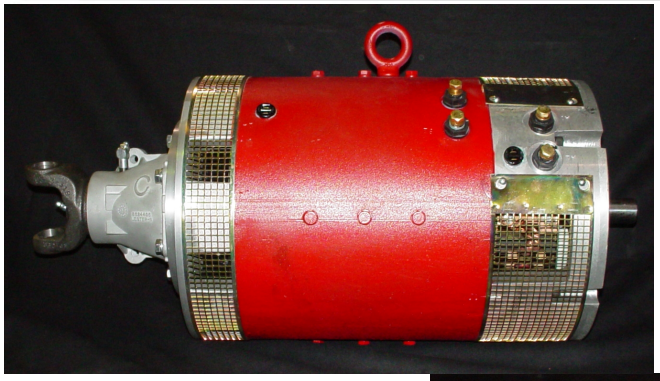
NetGain Motors, Inc.

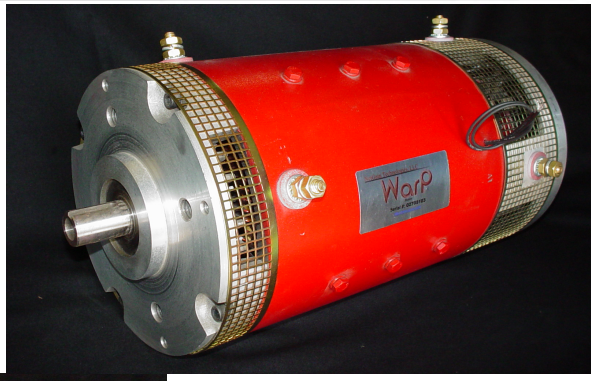
800 South State Street ⁄ Suite 4 ⁄ Lockport, IL 60441 ⁄ 630-243-9100 ⁄ 630-685-4054 (FAX)

Owner's Manual

for

WarP™ Motors





and

AmP™ Motors

Please record your motor serial number and date of purchase on this page.

Motor Serial Number: _____

Date of Purchase:_____

Purchased From:_____

Motor Model:

☐ ImPulse 8™	☐ ImPulse 9™	☐ WarP 8™
☐ WarP 9™	☐ WarP 11™	☐ WarP 13™
☐ TransWarP 7™	☐ WarP 7™	☐ TransWarP 9™
☐ TransWarP 11™	☐ WarP 11 HV™	☐ D-Sea 9™
☐ AmP 8™	☐ AmP 9™	☐ TransPulse™ 9
☐ OTHER		

Waiver Of Liability & Indemnification

It is the responsibility of the purchaser to be familiar with the safe and correct installation and operation for all equipment. The seller has no opportunity to supervise the application, installation, or maintenance of the components used, nor to supervise and inspect the replacement of the motors used. Therefore, the installer agrees that all motors will be used solely at the purchaser's risk. The purchaser will indemnify and hold the seller, its owners, and its employees or representatives free and harmless from all loss, liability, or damage resulting from the alleged failure or defect of any project built using components purchased from the seller.

April 18, 2017

RE: Your new **NetGain Motors, Inc.** DC Motor

It is with great pleasure that everyone at **NetGain Motors, Inc.**. welcomes you to the ***AmP*** ™ and ***WarP*** ™ motors owner's family! We would also like to "***Thank You"*** for your purchase.

Since electric motors are different from internal combustion engines, this Owner's Manual is being sent to you to provide information on running and caring for your new motor. Please read it carefully and follow the suggestions that will provide for years of great performance from your new motor.

This Owner's Manual contains the new motor warranty, our dealer's safety information sheet, wiring tips bulletin, heat and rpm protection bulletin, care and maintenance information sheet, bench test procedure bulletin and other information of interest and importance. If you purchased an AmP Motor your motor warranty will be provided by the Advanced Motors & Drives Warranty. All other motors are covered by Warfield Electric Company, Inc.

There is also a substantial amount of content that may be obtained at our website: http://www.go-ev.com

Along with your dealer, we definitely want to help make your EV project a success, so please let us know if you have any questions about your motor, safety, wiring or anything else. We'll help you or find resources that can help.

Again, we thank you for your motor purchase – we wish you success in your EV project!

WarP ™ **Motors – TORQUE ABOUT IT!**

George Hamstra
NetGain Motors, Inc.
President

WarP™ Motors

WARFIELD NEW MOTOR WARRANTY*

WARFIELD ELECTRIC COMPANY, INC. (The Company), warrants that new motors sold by it are merchantable and free of defects in material and workmanship at the time that they are shipped from the company's factory.

The company makes no warranty with respect to the new motors other than the warranty stated above. All implied warranties of merchantability and all express and implied warranties of any other kind are hereby excluded.

The company will repair or, at its option, replace any part of any new motor sold by it that fails to conform to the warranty stated above, provided Warfield Electric Company, Inc. (factory) is contacted for a Repair Authorization Number (RA#) and such part is returned to the company's factory or to a factory authorized service station, transportation charges prepaid, within the warranty period specified below:

> NEW MOTOR WARRANTY extends for a period of one year or 2000 hours of equipment operation, whichever first occurs, following the date of delivery of such equipment into which the motor has been installed, but warranty coverage will not exceed a period of two years from the date the motor was shipped from the company's factory. Proof of equipment installation date and equipment hour meter reading must be provided.

LIMITATION OF LIABILITY

The company's liability, whether in contract or in tort or under any other legal theory, arising out of warranties, representations, instruction or warnings (or any lack or inadequacy thereof), deficiencies, failures or defects of any kind or from any cause shall be limited exclusively to repairing or replacing parts (during normal business hours) under the provisions stated above. All liability for damages, including, but not limited to, those expenses, or injury to business credit, reputation or financial standing is hereby excluded.

The warranties contained therein shall not apply to or include any of the following and the company shall have no liability with respect to:

1. Repair or replacement required as a result of: (A) accident; (B) misuse or neglect; (C) lack of reasonable and proper maintenance; (D) operation in excess of recommended capacities; (E) repairs improperly performed or replacements improperly installed; (F) use of replacement parts or accessories not conforming to Warfield Electric Company, Inc. specifications which adversely affect performance or durability; (G) alterations or modifications not recommended or approved in writing by Warfield Electric Co., Inc. and (H) wear and deterioration of motor appearance due to normal use or exposure.
2. Normal replacement of consumable service items, such as brushes and brush springs.
3. Motors in equipment whose ownership has been transferred from the first purchaser for use to another.

* ***No agent of Warfield Electric Company, Inc. is permitted or authorized to change, modify, or amend any term of this warranty.***

AmP™ Motors

AMD NEW MOTOR WARRANTY

ADVANCED MOTORS & DRIVES

6268 E. Molloy Rd – E. Syracuse, NY = Tel: (315) 434-9303 = Fax: (315) 432-9290

ADVANCED MOTORS & DRIVES, INC.
WARRANTY POLICY

1. Scope

The following document states the warranty policy of Advanced Motors & Drives, Inc. Kinetek division. Unless otherwise specified, the term “Advanced Motors & Drives” shall include the Unites States Kinetek division, its affiliates of other Kinetek divisions, and their representatives, officers and employees. The warranty policy describes Advanced Motors & Drives, Inc. warranty obligations to its customers, the limitations of this policy, and summarizes the procedures regarding submission of warranty return claims, return of product, rejection and receipt of reworked or replacement material.

2. Limited Warranty

Advanced Motors & Drives, Inc. warrants to the original buyer (purchaser) of its motors that each of its products will be free from defects in workmanship and material, during the Warranty Period and subject to Limitations and Exclusions as delineated in this document.

3. Warranty Period

The Warranty Period begins on the manufacturing date of products shipped to the user.

The basic standard Warranty Period is of 1 (one) year or for the first 2000 (two thousand) hours of use, whichever occurs first.

A Warranty Period longer than 1 (one) year may be awarded under contractual agreements for specific Advanced Motors & Drives, Inc. products, subject to following Limitations and Exclusions.

If a warranty claim results in Advanced Motors & Drives, Inc. replacing the product, then the Warranty Period for the replacement will be the remaining unexpired portion of the original Warranty Period for the motor that was replaced.

4. Warranty Claim Procedure

4.1 Customer must submit the warranty claim within 30 (thirty) days of the occurrence of the alleged non-compliance or defect

4.2 Promptly upon customer’s communication, Advanced Motors & Drives, Inc. will provide Customer with a Returned Goods Authorization Number (RGA #)

R.A. Issued November 24, 2009
Rev A. April 20, 2010

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4.3 Customer must complete the Returned Goods Authorization Form. Customer must await receipt of RGA # before returning the motor to Advanced Motors & Drives, Inc. Customer must properly identify the returned motor. Customer will pay for the shipment of the returned motor.

4.4 Advanced Motors & Drives, Inc. will await the receipt of the motor before processing the warranty claim. If Advanced Motors & Drives, Inc. determines that the returned motor is covered under the Limited Warranty (item 2), Advanced Motors & Drives, Inc. will reimburse Customer for the actual cost of shipment of the returned motor.

5. Determination of Warranty Coverage

5.1 As soon as practical, Advanced Motors & Drives, Inc. will inspect the returned motor to determine if the motor is covered under Limited Warranty provisions.

5.2 Approval: If Advanced Motors & Drives, Inc. approves the warranty claim, the Customer will be reimbursed as delineated in Item 6, Remedy.

5.3 Denial: If Advanced Motors & Drives, Inc. denies the warranty claim, AMD will promptly communicate the reasons of denial of the claim

5.4 If Customer disagrees with the determination, Advanced Motors & Drives, Inc. and Customer will discuss the determination in good faith and solve the warranty claim amicably. If the determination cannot be resolved amicably, then Item 9 of the Warranty Policy shall apply.

6. Remedy

6.1 Approved warranty claims: Advanced Motors & Drives, Inc. will credit the customer with an amount agreed with the Customer and not higher then the original purchase price, or replace the motor free of charge, within 60 days of the warranty claim determination.

6.2 All credits issued under this Policy will be issued to the Customer's account. The Customer will not debit Advanced Motors & Drives, Inc. without specific written approval from Advanced Motors & Drives, Inc. or Kinetek's Controller or Finance Officer.

6.3 The remedy as stated under Item 6 provides for complete responsibility of Advanced Motors & Drives, Inc. for all warranty claims for non-compliance, or defects.

7. Limitations and Exclusions

7.1 The Limited Warranty applies exclusively to motors that have received normal use and service, and their application was approved by Advanced Motors & Drives, Inc. before purchase.

7.2 The Limited Warranty does not apply to: a). any motor that was dismantled, repaired or altered without prior consent from Advanced Motors & Drives,

ADVANCED MOTORS & DRIVES

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Inc. ; b) failure of the motor was the result of improper installation, vehicle accident or misuse.

7.3 The Limited Warranty does not apply to component parts that are subject to wear, for example bearings, brushes or seals.

7.4 This Limited Warranty does not cover any damage to the vehicle, compensation for loss of time or inconvenience, and does not provide for any liability for incidental or consequential damage arising from the use of the motor by its buyer, its assignees, Customers, agents or employees.

8. Disclaimer

Except for the Limited Warranty set forth above, Advanced Motors & Drives, Inc. makes no other representation or warranty, expressed or implied, arising by operation of law or otherwise, with respect to any product including, without limitations, the warranties of merchantability and fitness for a particular purpose whether or not the use or purpose has been disclosed in specifications, drawings or otherwise, and whether or not any product if specifically designed and/or manufactured by Advanced Motors & Drives, Inc. for the Customer' s use or purpose. The warranty set forth above is given in satisfaction of any and all obligations or liabilities of Advanced Motors & Drives, Inc. to any Customer, or any third party, with respect to the product, whether such liabilities or obligations arise out of contract, negligence, strict liability, tort or otherwise. Advanced Motors & Drives, Inc. shall not be liable for any property damage or personal injury to any Customer or third party, with respect to the product. Advanced Motors & Drives, Inc. shall not be liable to any Customer or any Customer's owners, officers, agents, employees, or subcontractors, or otherwise for any indirect, consequential, incidental, special, punitive or exemplary damages including without limitation damage or loss of profits or revenues, even if Advanced Motors & Drives, Inc. has been advised of the possibility of such damages.

9. Dispute Resolution

The interpretation, performance and completion of all transactions under the Limited Warranty Policy shall be governed by the Laws of the State of New York, without regard to or application of its principles, procedures or laws regarding conflicts of laws.

AmP™ & WarP™ Motors

Safety Information

<u>This is not an all inclusive list</u>. Use common sense and act responsibly, electric motors are extremely powerful and could cause death, dismemberment or other serious injury if misused or not safely handled!

Use caution when operating any motor. If you're not sure what you're doing, find a knowledgeable person to advise you!

Remove all metal jewelry and metal objects from hands, wrist, fingers, etc. before working on any electric motor.

If working on an electric vehicle, make certain the vehicle is positioned securely with the drive wheels safely clear of the floor and blocked up so that the drive wheels cannot make contact with the floor under any circumstances. Block the non-drive wheels if they remain in contact with the floor so that the vehicle cannot roll in either direction.

Before troubleshooting or working on any electric vehicle, disconnect the battery and discharge all capacitors. Reconnect the battery only as needed for specific checks or tests.

Motors must only be connected to a power source by knowledgeable and experienced personnel.

Motors should <u>NEVER</u> be run without a load. Running a motor without a load could result in harm to people or the motor. Absence of a load is considered misuse and could prove dangerous to anyone in the vicinity and void the motor warranty.

Portions of the motor may become hot and proper precautions must be taken.

Motors are heavy and are likely to become damaged if dropped, or cause damage to anything they fall upon (including people and body parts). Use extreme caution when working with motors!

Make certain the motor is disconnected from any power source before servicing.

Motors contain moving parts that could cause severe injury if the proper precautions are not taken. Never touch an operating motor.

Motors should never be operated beyond the limits established by the manufacturer.

Motors must not be modified in any manner; doing so will void the motor warranty and could prove extremely dangerous.

Wear protective or safety equipment such as safety shoes, safety glasses and gloves when working with motors.

Make sure you know where the closest functioning eye wash station is before working on or testing batteries.

Do not defeat any safety circuits or safety devices.

Under no circumstances should you push in any contactor of an electric vehicle while the drive wheels are in contact with the floor. Pushing in a contactor when the drive wheels are in contact with the floor can cause serious property damage, personal injury or death.

AmP™ & WarP™ Motors
Information

NetGain Motors, Inc's. AmP™ and WarP™ motors are produced by some of the nation's largest builders of series wound DC motors. Matching their experience and knowledge with our engineering and racing experiences, makes a perfect team to design motors that will perform under the unusual operational dynamics of electric vehicles.

All aspects of an electric motor were considered - from the components to the methodology of assembly - to make a motor that would perform in an electric vehicle.

Electric motors components are very critical in an electric vehicle, as are voltage and amperage, range, bearings, shaft sizing, commutator and brush coordination, windings and temperature range. Assembly steps critical to performance are clearances, brush "break-in", lacquering/baking process and overall quality of workmanship.

One area of serious study has been temperature. Where most DC motors are made to meet class F temperature rating (155º C.), our AmP™ and WarP™ motors all exceed class H ratings (180º C.) (Our WarP™ motors have been stress tested to 205º C). Whether using your DC motor for drag racing or for an everyday EV, temperatures will normally never approach 180º C. However, an external high volume fan or blower can be very effective in further dissipating motor heat, and additionally clears carbon dust from the brushes, which reduces risk of flash-over and would-be damage.

AmP™ and WarP™ motors are designed with an internal fan to provide cooling and motor protection during normal operation. All AmP™ and WarP™ motors are also configured with a temperature snap switch as a standard item (normally open) for early warning of an overheating situation. The snap switch is set to open at 120º C (150º C for 11" & 13" motors) and can drive an indicator light or warning tone in your vehicle or automatically close a circuit in your vehicle if it indicates overheating.

Motor ratings are given for the normal range of the motor's operation under various voltages and loads. Ratings with forced cooling have not been done since there are too many variables that cannot be controlled to allow the data to be useful. Needless to say, the motor will perform closest to its initial HP output the cooler one can keep it!

Some larger DC motors have interpoles. Because of the compactness of most motors 9" or less in diameter, in these horsepower ratings, interpoles cannot fit inside. Our WarP 13™ and WarP 11™ motors can have interpoles added, but they are not the standard configuration.

Lastly, please remember that AmP™ and WarP™ motors offer distinctive standard features on every motor that we feel make it the best choice for an electric vehicle motor in the industry. Some of these features are:

Standard AmP™ and WarP™ Motors Features

- ✔ Specifically designed for street and racing EVs
- ✔ Top quality, sealed, steel bearings with high temperature grease
- ✔ Motor temperature snap switch
- ✔ Brush Wear Indicators (on some models - eff. 4/2007)
- ✔ High efficiency fan
- ✔ Optimized brush timing
- ✔ Oversize brushes
- ✔ High quality brushes- not “quick-seat”
- ✔ Fully 90% plus brush wear-in[1]
- ✔ Heavy duty, vibration resistant, stainless steel brush springs
- ✔ Pre-drilled advanced timing holes for higher performance
- ✔ Insulation that exceeds Class “H” temperature rating
- ✔ Best in class patented varnishing process
- ✔ Voltage ranges starting at 48 Volts
- ✔ Interlocking commutator construction
- ✔ High peak motor efficiency
- ✔ Dynamically balanced armatures
- ✔ Hand made in the U.S.A. by experts

1 The brush wear-in process is completed before the brushes are placed into the enclosure so that no carbon dust is allowed into the motor.

IMPORTANT MOTOR INSTALLATION AND OPERATIONAL INFORMATION

PLEASE READ CAREFULLY

- BEFORE POWERING THE MOTOR THE FIRST TIME BE SURE TO CHECK AND ENSURE THAT BOLTS ARE NOT OBSTRUCTING THE FAN BLADES! FAN BLADES THAT ARE SHEARED OR DAMAGED BY USING BOLTS THAT ARE TOO LONG ARE NOT COVERED BY WARRANTY, NOR IS ANY SUBSEQUENT DAMAGE THAT MAY OCCUR TO THE MOTOR! TURN THE MOTOR BY HAND TO ENSURE IT TURNS FREELY AFTER SECURED TO THE ADAPTER PLATE.

- NEVER RUN THE MOTOR WITHOUT A LOAD AT MORE THAN 12 VOLTS! DOING SO COULD CAUSE THE MOTOR TO SELF DESTRUCT AND IS NOT A CONDITION THAT IS COVERED UNDER WARRANTY! NEVER REV THE MOTOR UP WHEN IN NEUTRAL OR WHEN THE CLUTCH IS DEPRESSED.

- NEVER USE YOUR BRAKE AND THROTTLE PEDAL AT THE SAME TIME. THIS COULD POTENTIALLY STALL THE MOTOR AND CAUSE IT TO BURN THE COMMUTATOR AND WILL VOID THE WARRANTY.

- NEVER USE THE THROTTLE PEDAL TO HOLD YOUR VEHICLE ON A HILL, THIS WILL STALL THE MOTOR AND CAUSE IT TO SCORCH THE COMMUTATOR AND WILL VOID THE WARRANTY.

- A STALLED MOTOR WILL DRAW AS MANY AMPS AS IT CAN AND RESULT IN RAPID OVERHEATING OF THE COMMUTATOR AND WILL VOID THE WARRANTY.

- A STALLED MOTOR WILL NOT BE COVERED BY WARRANTY. STALLING WILL BURN THE COMMUTATOR BARS AND IS CLEARLY VISIBLE DURING INSPECTION FOR WARRANTY.

- WARM COMMUTATORS CANNOT WITHSTAND THE SAME RPMs THAT A COOL COMMUTATOR CAN. UNDER COOL CONDITIONS THE MOTORS SHOULD NOT BE SPUN BEYOND 5,000 TO 5,500 RPMS, LOWER WHEN THE COMMUTATORS ARE WARM.

- MOTORS SHOULD IDEALLY BE RUN IN THE 2000-3500 RPM RANGE FOR PROPER COOLING AND EFFICIENCY. YOU SHOULD NOT REMOVE OR OBSTRUCT THE AIR INTAKES OR EXHAUST. REMOVAL OF THE FAN WILL VOID THE WARRANTY.

- BOLTS INSERTED INTO THE LIFT-EYE HOLES MUST NOT TOUCH THE FIELD POLE SHOES!

- THE FIELD POLE BOLTS IN THE CASE SHOULD NEVER BE REMOVED OR USED TO SECURE ANYTHING.

- YOU SHOULD NEVER WELD ANYTHING ONTO THE CASE. DOING SO CAN OVERHEAT THE ISULATION AND CAUSE PREMATURE FAILURE OF THE MOTOR.

Special Update

Date: April 13, 2005
To: All **AmP**™ and **WarP** ™ Motors Dealers
Subject: **AmP**™ and **WarP** ™ Motors Wiring (except **WarP 13** ™)

Several sources have recently inquired as to what the proper method was for wiring the terminal lugs on the cases of **AmP** ™ and **WarP** ™ motors . This ***Special Update*** clarifies the proper wiring method.

All **AmP** ™ and **WarP** ™ motors cases have four terminals, **A1**, **A2, S1, S2** stamped on the case at the factory. Motors are designed to normally operate in **C**ounter **C**lock **W**ise rotation at the **D**rive **E**nd (**CCWDE**) for forward vehicle operation. When a motor is specified as "advanced timing", it is assumed to be relative to the normal **CCWDE** rotation. Motors that do not have advanced **CCWDE** timing may be wired for **C**lock **W**ise rotation at the **D**rive **E**nd (**CWDE**). Advanced timing is alos referred to as "favored" timing. These instructions should help clarify the proper wiring method for both rotations.

AmP ™ and **WarP** ™ motors (except the **WarP 13** ™) should ALL be jumpered according to these instructions (battery polarity does not matter):

For **CCWDE** rotation wire as follows:*

CCWDE preferred connection method:
Connect **A1** to **S1**
Connect **A2** to one input power terminal and **S2** to the other input power terminal

CCWDE alternative connection method:
Connect **A2** to **S2**
Connect **A1** to one input power terminal and **S1** to the other input power terminal

For **CWDE** rotation wire as follows:

CWDE connection method:
Connect **A1** to **S2**
Connect **A2** to one input power terminal and **S1** to the other input power terminal

CWDE alternative connection method:
Connect **A2** to **S1**
Connect **A1** to one input power terminal and **S2** to the other input power terminal

Motors that have "advanced timing " for **CCWDE** rotation should not be run in **CWDE** mode. Doing so may damage the motor and void the warranty.

Dealers may request a motor be timed advanced for **CWDE operation by specifying this on their Purchase Order. This will be considered a "Special Order" and may involve an additional cost.*

Special Update

Date: October 24, 2006
To: All ***WarP*** ™ Motors Dealers
Subject: ***TransWarP 11*** ™ Motor Wiring and errata*

Normal wiring for **C**ounter **C**lockwise **R**otation when viewed from the **D**rive **E**nd (**CCWDE**) of a ***WarP*** ™ , ***ImPulse*** ™ or ***TransWarP 9*** ™ motor is: **A1-S1** or **A2-S2**.

However, on the ***TransWarP 11*** ™ the wiring for **CCWDE** is: **A1-S2** or **A2-S1**. For **CWDE** the wiring on these motors is **A1-S1** or **A2-S2**.

Additionally, all of the **NetGain Motors, Inc.**. 11-inch and 13-inch motors incorporate a 150° C snap switch. Other motors utilize a 120° C snap switch.

Wiring information for other ***AmP*** ™ and ***WarP*** ™ motors may be found in the ***Special Updates*** dated 04/13/2005 and 03/01/2006.

You may locate copies of these and all other ***Special Updates*** on our Web Site at:

http://www.go-ev.com/dealers-only/Dealer_Manual

All motors produced in 2007 will incorporate 2 lifting holes to aid installation. These holes will be positioned 90 degrees apart in order to allow better positioning of the terminal studs.

Broken fins, which occasionally occurred on ***ImPulse 9*** ™ and ***WarP 9*** ™ motors due to the placement of advanced timing holes, will now be machined during assembly.

Dealer input is always welcomed, if you have any suggestions on how we might improve our motors, please contact us! 04/13/2005 and 003/01/2006.

You may locate copies of these and all other ***Special Updates*** on our Web Site at:

http://www.go-ev.com/dealers-only/Dealer_Manual

* Beginning in 2008, all new ***TransWarP 11*** ™ motors will be produced so they are wired identical to all other ***WarP*** ™ motors. If you purchased your motor prior to 2008 you should verify correct rotation prior to installation!

Special Update

Date: February 13, 2006
To: All AmP ™ and WarP ™ Motors Dealers
Subject: AmP ™ and WarP ™ Motors Heat and RPM Protection Bulletin

Throughout the year we have had inquiries about the effects of heat and RPM's on AmP ™ and WarP ™ motors. This **Special Update** summarizes many of our conversations with individual dealers and shares the same knowledge across our entire dealership network. As in our other **Special Updates** , this information does not cover every aspect of the motor's usage. If you have a situation that you are unsure about, please call someone that has the expertise or seek more detailed information. Please act responsibly and protect yourself and your customer from personal harm or damage to the motor.

Motor Heat

1. All AmP ™ and WarP ™ motors are rated over Class H, which is 180 degrees C, but one still needs to protect the motor from overheating
2. If you are using your motor for drag racing, with 10-20 seconds of high load, the brushes and comm will heat up faster than the other parts of the motor. To protect your motor in this case, measure temperature in the brushes and the comm surface area using an infrared device that can react quickly. Heat can build very fast, as you would expect and may already know!
3. If your motor is used for normal vehicle travel, the ends of the pole shoes and the motor case by the shoe bolts will generally be the area of greatest heat build up. To protect your motor in this area, the normal temperature snap switch is installed. Connect it to give the driver a warning light or to automatically open the circuit if it indicates overheating. Heating will build slower here, but fast action needs to be taken to protect the system.
4. Consider setting a temperature of 110-120 degrees C for your action starting point as a safe way to manage a potential overheating situation.
5. Lastly, always ensure that sufficient and proper air circulation through the motor is not impaired!

Motor RPM

1. All AmP ™ and WarP ™ motors have commutators that were tested to over 8,000 RPM, but that does not mean they can be run at that speed indefinitely!
2. Most motor commutators built now are composite. Steel commutators were used in the past, but are now made for custom orders and very expensive. Steel core commutators are generally able to withstand higher RPM speeds.
3. We like to recommend safe speed ranges from 2000- 3500 RPM, even though we know some of our AmP ™ and WarP ™ motors are peaked around 5,000 RPM for small intervals of time. When working with a customer, please be sure to design gearing so that the customer gets the speed he wants, but the motor will not be at a high RPM for long periods of time.
4. Lastly, utilize one of the many ways available to protect the motor from exceeding 8,000 RPM and make sure it is installed and working properly. It just needs to work once to pay for itself, save the motor and protect all the people around the vehicle!

Special Update

Date: February 15, 2006
To: All AmP ™ and WarP ™ Motors Dealers
Subject: AmP ™ and WarP ™ Motors Care and Maintenance

This ***Special Update*** summarizes many responses we have given to dealers and customers alike about motor care and maintenance. As the sphere of users continues to grow for electric motors used in vehicles, knowledge about motors needs to be communicated to all those users across our entire dealership network. As in our other ***Special Updates*** , this information does not cover every aspect of the subject.

Here are a few simple steps one should take to help the AmP ™ and WarP ™ motors provide years of great performance.

1. Protection from the elements is important. Utilize good design concepts and materials to protect the motor from rain, snow and ice.

2. Design the motor mounting area to allow for good air flow. The motor needs a continuous supply of clean fresh air to cool properly.

3. Protect the motor from “dirty air” that may be used to cool it. Most airborne grit will act as an abrasive, which will eventually cause harm to the internal parts of your motor.

4. Clean the brushes and comm area regularly from the dust/dirt that occurs during normal operation.

5. Regularly check connections, voltages, tolerances and alignment to assure they are within normal specifications.

6. If you suspect or question the motor's operation, immediately shut it down. Record any visual signs, audio sounds or scents at the time and ask an expert for an opinion prior to operating the motor again.

7. Always operate the motor within the normal safety ranges for voltage, amperage and RPM

8. Follow all the safety rules available to you.

9. Remember your motor will take care of you, if you take care of it.

AmP™ and WarP™ Motors
Series Motor Bench Test Procedure

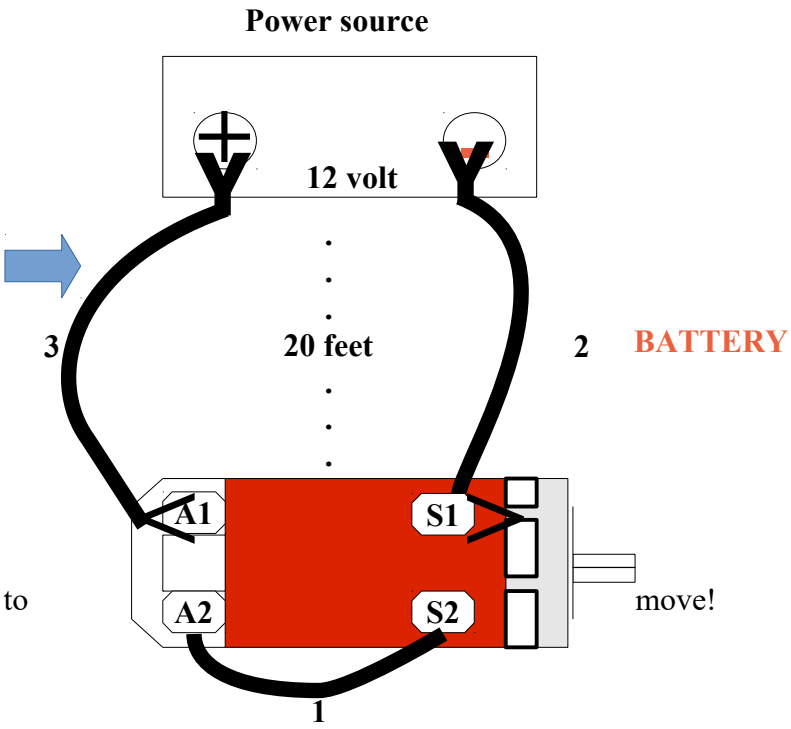
(Test at 12 volts ONLY)

CAUTION! Read completely!

Caution!!!!
Sparks can ignite gases emitted from batteries!

Use quick-connect cables for battery and motor!

DO NOT HARDWIRE MOTOR AND CONNECTIONS!



Make certain that the motor is securely strapped or bolted in position. The motor must **not** be allowed to move!

If a battery is used instead of a charger, the battery must be at least 20 feet away from the motor in a well ventilated area or preferably outside of the building!

The cables **MUST** be **connected and disconnected** in the order shown!

Connecting sequence:

1. Connect cable #1 and cable #2 first.
2. Connect cable #3, to power source positive terminal (+) at the power source first, NOT at the motor.
3. Connect the other end of cable #3 to terminal (A1) at the motor which is 20 feet away from the power source.
4. Disconnecting sequence:
5. Disconnect cable #1 first. (This deactivates the motor)
6. Disconnect cable #2 and then #3 from the power source.

Selecting EV Components

The Vehicle

There are numerous factors to consider in trying to select the appropriate components for a particular conversion product, and they go hand-in-hand. The intended user of the vehicle should first define their intended application. Some people define “performance” as being able to achieve the greatest range with their vehicle. Others may define performance as achieving a particular speed in a specific time. It is important to determine what the performance goals are for a vehicle before choosing the vehicle. If someone is looking for range and chooses a vehicle for conversion that does not have room for batteries, they will likely be disappointed in the end result. Similarly, if someone is looking for the quickest 0-60 miles per hour time and selects a heavy vehicle they might also be disappointed. Knowing the performance expectations can help determine an appropriate vehicle for conversion.

An ideal vehicle is one that has the existing braking capacity, as well as the suspension capacity to handle the weight of the batteries and other components installed during the conversion.

It is advisable to measure the height to the top of each wheel opening on the vehicle before any conversion is undertaken. Ideally, this should be the height after the conversion is completed. Obtaining the proper ride height and suspension travel is crucial to the vehicles handling and safety. It may be necessary to have a company that specializes in suspension suggest alternatives after the vehicle has been converted.

In some cases a vehicle that is already owned is chosen for conversion simply because the customer already owns it. It may not be an appropriate vehicle, but the decision has already been made.

The Batteries

The rule-of-thumb when using lead-acid batteries for a conversion is that the vehicle will end up weighing about 1,000 lbs more than it did before the conversion and usually have a range of 20-30 miles. Certainly, some people have converted vehicles with 50+ mile ranges using lead-acid, but the extra range comes at the expense of load carrying capacity. It is best to know and consider the effect of adding 1,000 lbs of weight will have on the vehicles handling and braking capacity.

Besides the weight of the lead-acid batteries, the voltage is known to sag severely during heavy amperage draw. Lead-acid (PbA) battery range may be cut in ½ during cold weather. The typical life of PbA batteries is normally around 2-3 years in an EV application. The normal “starting” batteries used in ICE vehicles are generally not considered a good candidate for EV's as they usually cannot handle the heavy charge and discharge cycles. The most commonly used PbA battery are the golf-cart style batteries. But, these “flooded” batteries will require constant checking of the electrolyte levels, and they generally cannot deliver the amperage required in modern EV's. Flooded golf-cart style batteries can provide the best range of PbA batteries, and their life can be 4+ years if properly maintained. This does come at the cost of a lot of weight.

Lighter and more powerful PbA batteries known as “absorbed glass mat”, and even better “spiral wound” batteries will allow higher amperage draws, but the range will typically be around ½ of what the large flooded batteries will deliver. But these types of batteries can generally deliver higher amperage over a longer period than flooded type batteries.

Whenever economically feasible, Lithium Iron ($LiFePO_4$, $LiYFeSO_4$, or similar) battery chemistry should be considered. Besides the improvement in the amperage that can be delivered, the LiFe batteries are not nearly as sensitive to cold weather or high temperature, and the voltage does not sag as deeply under heavy amperage

draw. It is not unusual for someone to have a Li powered vehicle that has a 70-90+ mile range, and perform very well. In part the improved performance is due to the much lower weight of the Li batteries, but also due to their ability to supply high amperage.

The Controller

In most vehicles being converted a 1,000 Amp or higher controller should be considered. Certainly, 500 Amp controllers have worked well for many years, and since the older style PbA batteries may have only been capable of 300 Amps discharge, a 500 Amp controller was sufficient. Indeed, if a vehicle only requires 150 Amps to travel at it's average speed, so the use of a 1,000 Amp controller will not offer any advantages – EXCEPT at start-up! And, the difference between 500 Amps and 1,000 Amps at start-up can be quite significant with most motors capable of close to 4 times the torque at 1,000 Amps that they produce at 500 Amps. LiFe batteries exist today that can discharge 4,500 Amps, and the potential of these batteries is improving rapidly.

If you have a heavy vehicle, you need the higher amperage controllers. Often times, people think it is easier on a motor to only provide it 500 Amps rather than 1,000 Amps. Though 500 Amps will produce less heat than 1,000 Amps, you must take into consideration whether the amperage will provide the necessary torque the motor needs to start rotating. If the amperage isn't high enough to start the armature spinning, all of the 500 Amps will be split between just a couple of commutator bars. If the armature doesn't turn it is considered a stall condition, and the heat build-up can quickly cause a commutator bar to raise. A stall condition is not covered under warranty, and the condition is quite easily determined by the scorch marks 90 or 180 degrees apart on the commutator.

The speed that the vehicle will be able to obtain is determined (in part) by the voltage that is delivered to the motor – not necessarily by the voltage that is delivered to the controller. When a new off-shore manufacturer of controllers entered the market a few years back, we were swamped by calls from users of this new 120 Volt 1,000 Amp controller who could not get their vehicles over 30 MPH. Users naturally accused the motor of not being able to power their vehicle, when the actual cause of the problem was that the controller was only able to deliver 36 Volts to the motor. Volts = RPMs in a nearly linear manner with series wound motors. If the voltage to the motor doubles, the motor RPMs will double. Since most losses are fixed, the RPMs may increase slightly more than double.

EV racers found it necessary to build 336 Volt + battery packs due to the fact that 12 Volt PbA batteries would sag to 5.5 Volts when 1,400 Amps were drawn from them. If the motors are capable of handling 168 Volts, and the PbA battery pack is 168 Volts nominal, then the motor would only see about 77 Volts when 1,400 was drawn from the battery pack. In order to deliver the maximum voltage to the motor, it became necessary to increase the PbA battery pack voltage. As LiFe chemistry battery voltage typically sags far less under heavy amperage draws (25% vs 50%), the battery pack voltage need not be as high as a comparable PbA battery pack voltage.

The Motor

Matching all the components of an EV is a critical aspect of any conversion. Choosing batteries that can't discharge high enough current may mean that the controller won't be able to supply the motor with the amperage it may need for a particular job. Choosing a controller that can't supply the motor with the current it needs to perform will likely result in a conversion that doesn't meet expectations. Choosing a battery pack that is too low a voltage may limit the speed the vehicle is able to attain. Choosing a motor that is too small for a

vehicle will lead to the motor heating up and being overworked and possibly leading to motor failure. Choosing a motor that is too big for an application may lead to the motor "lugging" which will normally result in

commutation problems over time, and eventually to other motor problems.. For the best electric vehicle experience, it is essential that the electric motor be carefully sized to the vehicle for which it is intended. Simply using a "bigger motor" for a larger or heavier vehicle is not necessarily the best way to match components. Likewise, choosing a motor that is simply too small for an intended application is also likely to end up with an undesired result as the motors may overheat.

Many factors are used to determine which motor is suitable for the weight (and aerodynamics) of the vehicle to be propelled and the speed which is to be maintained. There are some online tools which can tell you how a vehicle might perform under varying conditions, such as: http://www.evconvert.com/tools/evcalc/ But, even excellent tools such as this cannot take all the various battery, controller, and motor options into account.

NetGain Motors, Inc. is will assist Authorized Motor Dealers or their customers in trying to size the right motor for their particular application, however we prefer to provide the Authorized Motor Dealer with the information so that they remain the primary point of contact with the customer. In order to assist Authorized Motor Dealers in motor selection, we need to be provided with as much of the following pieces of information as possible:

- Battery Pack Information
  - Voltage
  - Internal resistance
  - Discharge capabilities
- Motor Controller
  - Voltage capabilities
  - Amperage capabilities
- Vehicle Characteristics
  - Vehicle weight (after conversion)
  - Top speed to be maintained on level terrain
  - Top speed to be maintained on grade
  - % grade
  - Gear ratios of transmission
    - Gear efficiency
  - Rear differential gear ratio
  - tire diameter
    - Type of tire/surface (i.e. rubber on concrete)
  - Coefficient of drag
  - Frontal area

It is possible that the customer will have unrealistic goals, objectives, or understanding of a technology they are unfamiliar with. It is unlikely that you could suggest a motor combination that would provide a 0-60 MPH of 2.9 seconds and a top speed of 250 MPH with direct drive in a 4,000 lbs vehicle at 48 Volts.

Direct driving a vehicle with an electric motor sounds simple, and it is the first thing that many people believe they want. However, to properly direct drive a vehicle considerations must be given to the safety of the vehicle and the workmanship of the conversion. A mistake in wiring a direct drive conversion leaves little room for

mistakes. It is unlikely that the brakes of the vehicle would be sufficient to stop an electric motor receiving full-power. Without a manual disconnect (such as a clutch, or neutral transmission gear), it could prove extremely dangerous or fatal for the driver and occupants of the vehicle or even bystanders. There are benefits to direct drive, in that the normal transmission losses may be eliminated. This is useful when racing, but offers little benefit to a "daily driver" type of vehicle. Although direct drive works well for racing, it is not advisable for around town driving as the motors should normally spin 2000 - 4000 RPMs in order to properly cool. Forced air cooling is highly encouraged to help cool direct drive motors, as well as vehicles that are used in stop and go (around town) driving.

There are also significant drawbacks to the use of direct drive vehicles, beyond just the safety issue. Direct drive will normally require twice the motor and twice the controller of a vehicle with a transmission (a 2000 Amp controller rather than a 1000 Amp controller) Either a larger motor will be needed for direct drive, or a second motor which will add additional weight and consume additional space will be needed. This will normally offset the customer's expected savings of a direct drive configuration. Additionally, dual motors will require a more complicated wiring scheme in order to allow for reverse direction movement of the vehicle. Dual motor direct drive also decreases the overall electrical efficiency of the system slightly.

The motors enjoy spinning at 2,000 - 4,000 RPMs. You should always design your conversion so that the normal operating RPMs of the motor are within this range. You may accomplish this by modifying the gear ratios (transmission and rear differential) and tire diameters. In general, the electric motors prefer spinning about 1,000 RPMs higher per gear than the original internal combustion engine did.

PbA Battery Vehicle			
Direct Drive Motor Selection[2]			
Motor	**Vehicle Weight**	**Dual Coupling Motor**	**Vehicle Weight**
TransWarP 7 ™	~1,400 lbs	***WarP 7*** ™	~2,800 lbs
TransPulse 9 ™	~1,600 lbs	***ImPulse 9*** ™	~3,200 lbs
TransWarP 9 ™	~1,750 lbs	***WarP 9*** ™	~3,500 lbs
TransWarP 11 ™	~2,100 lbs	***WarP 11*** ™	~4,200 lbs
TransWarP 11HV ™	~1,900 lbs	***WarP 11HV*** ™	~3,800 lbs

The use of a transmission normally allows you to double the figures of the first table:

PbA Battery Vehicle	
Transmission-ed Vehicle Motor Selection	
Motor	**Vehicle Weight**
WarP 7 ™	~2,800 lbs
AmP 8 ™	~3,200 lbs
ImPulse 9 ™	~3,200 lbs
WarP 9 ™ or ***Amp 9*** ™	~3,500 lbs
WarP 11 ™	~4,200 lbs
WarP 11HV ™	~3,800 lbs

2 Direct Drive assumes that a differential with additional gearing is still being utilized.

Dual motors also allow for alternative wiring schemes (series/parallel) that can provide greater flexibility and performance.

The motors enjoy 120-156 volts, no higher than 170 to the armature is recommended – though people utilizing the motors for racing are, in some cases, providing the motors with 208+ Volts. You should never apply full power to a motor unless the brushes are 100% seated. The battery pack should be as stout as the controller can handle as the voltage of PbA batteries will sag to 6-7 volts when drawing 1000 amps at start-up (from lead-acid batteries, Lithium will also sag, but not as significantly, generally around 20-25%). With series wound DC motors, **Volts = RPMs** in a nearly linear manner - double the volts and you double the RPMs and horse power (hence the need for a stout battery pack). **Amps = Torque**. The motors will draw all the amps they can to start spinning (max torque at stall). Amps and Torque are a non-linear relationship – doubling the amperage will quadruple the torque until saturation of the motor occurs.

Lithium Battery Vehicle			
Direct Drive Motor Selection[3]			
Motor	**Vehicle Weight**	**Dual Coupling Motor**	**Vehicle Weight**
TransWarP 7 ™	~1,200 lbs	***WarP 7*** ™	~2,400 lbs
TransWarP 9 ™	~1,600 lbs	***WarP 9*** ™	~3,200 lbs
TransWarP 11 ™	~2,000 lbs	***WarP 11*** ™	~4,000 lbs
TransWarP 11HV ™	~1,600 lbs	***WarP 11HV*** ™	~3,200 lbs

The use a transmission allows you to double the figures of the first table:

Lithium Battery Vehicle	
Transmission-ed Vehicle Motor Selection	
Motor	**Vehicle Weight**
WarP 7 ™	~2,400 lbs
AmP 8 ™	~2,800 lbs
WarP 9 ™ or ***AmP 9*** ™	~3,200 lbs
WarP 11 ™	~4,000 lbs
WarP 11HV ™	~3,200 lbs

With a transmission, you can usually double the weights normally associated with a single motor direct drive. The following table may be used as a general reference, but may not be applicable to all situations. The frontal area, and coefficient of drag greatly effect power requirements with speeds greater than 45 MPH. The gradient, gear ratios and surface of the road will have a significant effect on the vehicles ability to perform as expected.

3 Direct Drive assumes that a differential with additional gearing is being utilized.

Selecting EV Components

The use of Lithium batteries will also affect the decision on which motor[s] should be used. Due to the fact that Lithium powered vehicles can drive for extended periods of time, the one hour rating on motors may be exceeded. Consequently, either a larger motor, more motors, or lower weight will be required to not exceed the motor ratings.

Though figures from both tables are considered conservative, you must consider the additional load placed on the vehicle by the weight of the vehicle operator and passengers. Pulling or carrying an additional load is not considered in these figures, nor the affects of high-speed operation (both RPMs and MPH). These figures are "approximate" (~) and you may have better or worse experiences depending upon other variables in your application. If in doubt, we suggest you contact us to discuss your application.

Motors may be stacked, or combined in-line with one another in order to handle additional loads. The terrain (i.e. hills) will greatly affect the motor choice.

Driving an EV

People who are new to driving EV's should understand a few of the basic differences between the ICE vehicles they are used to driving and EV's. Whereas the typical ICE develops horsepower and torque as the RPMs increase, the typical series wound DC motor produces maximum torque at stall. Thus it is possible to start a vehicle from a dead-stop in 2nd or 3rd (sometimes 4th) gear! Of course it is easier on the electric motor to start in a lower gear, and the motors enjoy being run in the 2,000-4,000 RPM range, so choose your gear appropriately.

Never try to "hold position" on an incline with your electric motor. If someone is stopped at a stoplight on a hill and tries to hold position using the electric motor, a "stall condition" will occur and likely damage the electric motor. It is highly encouraged to use the brakes to hold position rather than the electric motor.

Don't try to move the vehicle forward if the motor is spinning in the reverse direction. In other words, if you are rolling backwards, make certain the motor is stopped before applying power to move forward. This only pertains to direct drive vehicles. In vehicles with a transmission the electric motors are not affected by the direction or movement of the vehicle. But, even if you have a transmission, it is far easier on the motor if the vehicle isn't rolling backwards.

You may be able to pass a vehicle quicker by up-shifting with an electric motor powered vehicle, rather than down-shifting as is normal in ICE vehicles. When an increased load is placed on the electric motor (such as by up-shifting), it will draw greater amperage and produce greater torque and allow quicker acceleration.

It is not necessary to "rev" the electric motor when moving from a standstill. The electric motors torque curve actually decreases as the RPMs increase, so you may have better performance by not revving the electric motor. Of course, if a clutch is used, the electric motor can certainly be revved to allow easy acceleration as was normal with the ICE. But, it is not required. "Slipping the clutch" may be useful on hill starts, but normally not required.

Choosing the right gear for a given speed can take some time to determine. Though not necessarily the optimum, it is "generally" best to run the electric motor at about 1,000 RPMs higher per gear than then the ICE was used. The motors prefer to spin 2,000 to 4,000 RPMs to properly cool themselves. If running below 2,000 RPMS for extended periods, or in stop and go traffic, a forced air blower can be utilized to cool the motor, and can make a significant difference in motor temperature. To determine whether you are in the correct gear, you may need to up-shift and down-shift for awhile till you find the gear where the motor is spinning in the 2,000 to 4,000 RPM range, AND, the amperage draw is the lowest.

EV Routine Maintenance

In addition to the “normal” maintenance that may be required on any vehicle you own or operate, some special considerations must be given to electric conversion vehicles. It is critical that some routine maintenance be performed on your electric vehicle. Whether your vehicle is a daily driver, a race vehicle, a boat, or any type of electric vehicle, you must perform some routine maintenance to ensure long life of your components and continued operational safety.

The exact routine will vary by the type of vehicle, the components utilized, and the use of the vehicle. For instance, if you have a vehicle that utilizes flooded lead-acid batteries, you will need to check the water in the batteries on at least a monthly basis. Regardless of the type of batteries you are using, you should plan on checking the tightness of all electrical connections on some regular basis. A loose or corroded connection can cause loss of power, or arcing and sparking that could prove hazardous! Arcing and sparking can lead to a fire, so it is strongly encouraged that an appropriate fire extinguisher be readily accessible in your electric vehicle.

We highly encourage the use of Nord-Lock (http://www.nord-lock.com/) lock washers wherever suitable! At the very least, the use of Belleville style or toothed lock washers are required. This includes all motor terminals, as well as all battery connections. This is even more critical when the EV is used near salt water. The Nord-Lock washers are corrosion resistant. Their standard steel washers are zinc flake coated with Delta Protekt® and endure a minimum of 600 hours of salt spray test in accordance with ISO 9227.

If you have a racing vehicle, it is important to use compressed air after EVERY race event in order to help expel carbon dust that accumulates. This is important with all brushed DC motor vehicles. Blowing out the carbon dust is required and reduces the possibility of a ground to the frame through the electric motor or an internal shorting or arcing situation.

You should protect the electrical connections and the motor from environmental contamination, such as salt spray, that could corrode components and/or damage the motor. Contaminants, such as dust, will act as an abrasive on the brushes and commutator. Dust can even be sucked through the motor and wear the internal insulation and even cause internal arcing to occur. We highly encourage the use of forced air blowers and air filters on most motors. If you do not use a filter and blower to protect your motor, you should consider a shroud of some sort to help avoid road debris from entering the motor. It is safe to use a LIGHTLY oiled rag to wipe down and remove dirt from the motor case.

Remember, NEVER use silicone around brushed DC motors. This includes silicone fumes. Silicone can cause the rapid degradation of the brushes used in brushed DC motors and also lead to damage of the commutator and other motor components.

Frequently Asked Questions (FAQ)

Last updated: April 18, 2017

Welcome to the **NetGain Motors, Inc.** Frequently **A**sked **Q**uestions (**FAQ**). This document will attempt to answer many of the questions that we are asked related to our products. It is not intended to provide answers to all your questions. We suggest you contact one of our **Authorized Motor Dealers** for further assistance and guidance.

1. **Where did the *WarP* ™ name come from?**

   We do enjoy *Star Trek,* however, that had very little to do with the original name selection for our motors. The name was a natural way of showing that we intended on incorporating new and advanced thinking in the enhanced designs of the motors we planned on building. The "***War***" portion of the name comes in part from the name of a motor manufacturer that was instrumental in our original designs (and subsequent designs, as were John Wayland and numerous others...). The capital "***P***" at the end of the name is also significant. It stands for "Phil Brown", a close friend and supporter of our original electric dragster concept vehicle. Unfortunately, Phil was taken by cancer prior to the project gaining momentum. We intend to maintain this method of honoring **P**hil in the naming of our ***ImPulse*** ™, and ***TransWarP*** ™ motors as well. The ***HyPer*** ™motors are our new line of AC motors, while ***AmP*** ™ ***WarP*** ™ , ***TransWarP*** ™ and ***ImPulse*** ™ motors represent our DC line of motors. All ***TransWarP*** ™ motors have a 32-tooth involute spline shaft that matches the transmission output shaft of a Chevrolet Turbo 400 transmission.

2. **Where did the *AmP* ™ name come from?**

   The "***Am***" portion of the name comes from the name of the motor manufacturer that actually contract manufacturers our motors for us. The capital "***P***" at the end of the name still stands for "Phil Brown"

3. **Which *AmP* ™, *WarP* ™, *ImPulse* ™ or *TransWarP* ™ motor should I use?**

   The answer to this question depends upon MANY factors! We would be happy to discuss which motor we feel meets your needs the best, and to run your requirements through our motor selection software. The first question you should ask is: What is the intended purpose of the vehicle? Will it be used as a "daily driver"? Will it be used strictly for racing? Will it be a performance vehicle, or will it be designed for greatest range between charges? In addition to knowing the answers to these questions, you should have some realistic thoughts relating to:

   I. Top speed to be maintained on level terrain _____
   II. Top speed to be maintained on grade _____
   III. Percent grade the vehicle will travel on _____
   IV. Wind resistance (frontal area) of the vehicle _____
   V. Total vehicle weight (with driver/passengers/load) _____
   VI. Final gear ratio _____
   VII. Tire Diameter _____

VIII. Voltage to be supplied to the motor _____
IX. Coefficient of drag _____
X. Battery internal resistance _____

4. What is the difference between the *AmP* ™, *WarP* ™, *ImPulse* ™, *TransWarP* ™, and *HyPerDrive* ™ Motors?

The ***AmP*** ™ line of motors are the newest addition to our DC motor offerings. **The *AmP*** ™ motors are particularly well suited to street driven EV's, whereas the other motors are primarily suited to racing applications. The ***ImPulse***™ line of motors were designed to be lower power and/or smaller motors than our traditional ***WarP*** ™ series motors. The ***ImPulse 9*** ™ is shorter than a ***WarP 9*** ™, and is less powerful. However, it is more powerful than the 8" diameter motor it was designed to replace. In addition to being more powerful than an 8" motor, it shares many of the beefy components of the ***WarP 9*** ™ motors (commutator, bearings, brushes, etc.). The ***ImPulse 9*** ™ also has the same bolt pattern and mounting characteristics of an 8" motor. The ***WarP*** ™ motors are our most common motors. The ***WarP 9*** ™ and ***WarP 11*** ™ were designed to be interchangeable with one another. The ***WarP*** ™motors are the most common motors we make for EV conversions. The ***TransWarP*** ™ motors were designed to meet the needs of direct drive, racing applications, as well as being used by ***EMIS*** ™. The "rule of thumb" when dealing with direct drive applications is that #1 it is not good for use as a daily driver #2 it will require twice the motor and twice the controller of a vehicle with a transmission. Our latest offering is the ***HyPerDrive 9*** ™ motor. These are actually two specially race prepped ***WarP 9*** ™ motors with different shafts, brush rigging, etc. from our normal ***WarP*** ™ motor. The ***HyPerDrive*** ™ were originally set of two matched motors that were designed to be fitted together and work as a single motor. The "***Pe*** " portion of the name is my thanks to Mike **Pe**thel who helped with the development of this radical design. Since we no longer plan to produce these motors, we are planning to use the name for our new line of AC motor controllers.

5. How do I become a dealer of *AmP* ™ and *WarP* ™ Motors?

You should visit our Web Page (http://www.go-ev.com) and print a copy of the **Dealer Application**. Fill out the form completely and FAX it back to us. You must have a valid existing business with a state resale sales tax number in order to even begin the process. We also consider proximity to other Dealers, experience converting vehicles to electric, and other factors, web only Dealers will no longer be considered.

6. What is an ICE, what is an EV, Hybrid?

ICE stands for **I**nternal **C**ombustion **E**ngine. **EV** stands for **E**lectric **V**ehicle. A hybrid vehicle is one that uses a mixture or combination of technologies to propel the vehicle. Hybrids are generally one of two types: series or parallel. A parallel hybrid uses multiple, possibly combined, means of powering the vehicle, while a series hybrid generally uses a source to produce electricity in order to power an electric motor that actually drives the vehicle. Almost all ICE vehicles "could be considered hybrids since they include an electric motor to start the ICE, but we won't go there...

7. What do the abbreviations "*DE*" and "*CE*" stand for?

"**DE**" stands for "**D**rive **E**nd". This is the end of the motor that usually contains the fan and usually has a larger diameter shaft. "**CE**" **stands** for "**C**ommutator **E**nd". This is the end of the motor where the brushes and commutator are. Motors that are specified as "no **CE** shaft" do not have a shaft extending from this end. "**CE**" is also the abbreviation used by Dennis Berube for his world record holding electric

dragster: **C**urrent **E**liminator.

8. **What do the abbreviations "*CCW*" and "*CW*" mean?**

   "**CW**" stands for "Clock-Wise" rotation and "**CCW**" stands for "Counter-clockwise" rotation. These abbreviations are normally used in conjunction with "**DE**" and "**CE**" to indicate the perspective of the armature rotation. For instance: "**CCWDE**" would indicate Counter-clockwise rotation when viewed from the **D**rive **E**nd – this is the default for all ***AmP*** ™ and ***WarP*** ™ motors with the exception of the ***TransWarP 7*** ™ which is neutrally timed from the factory (but may be ordered with advanced timing. **CWDE** would indicate "Clock-Wise rotation when viewed from the **D**rive **E**nd. Most vehicles require **CCWDE**, however, some vehicles (i.e. Honda transmissions) may require **CWD**E. You should verify the rotation prior to ordering as the timing can be requested to be advanced timed for the rotation of the motor.

9. **What is "Timing" on an an electric motor?**

   Timing an electric motor refers to the area of the commutator that is being energized has been moved from a normally centered position. Normally, brushes are fixed into a position on the commutator during the manufacturing process. The position they are normally set at from a manufacturer is a "neutral" position. A "neutral" position allows the motor to operate and perform almost identically in **CCWDE** and **CWDE** rotations at normal voltages. A normal voltage for most series wound motors in a neutral timed arrangement is generally less than 96 volts. Above this voltage motors should almost always be advanced in the direction of their normal rotation in order to reduce arcing, improve RPMs, and to provide increased performance at higher voltages. **CAUTION: If a motor is advance timed and then powered to run in the opposite direction of the advancement, significant arcing and damage could result if high power is applied! Re-gen should not be attempted with motors that have been advance timed!**

10. **How do I know how much to advance the timing on a motor?**

    All new ***AmP*** ™ **and** ***WarP*** ™ motors have pre-drilled holes that allow the commutator end-bell to be removed and the brushes re-positioned in a neutral, or an advanced position, either **CWDE** or **CCWDE**. ***WarP*** ™, ***ImPulse*** ™, ***TransWarP*** ™ motors are each advanced ~12 degrees while the ***AmP 8*** ™ motor is advanced ~10 degrees. The amount of advancement is based upon the width of the brushes, the number of commutator bars, the diameter of the commutator and various other factors that are monitored when the motor is run on a dynomometer. The proper terminology used to describe an advanced timed motor would be "advanced timed, **CCWDE**" or "advanced timed **CWDE**". The term "retarded" that is often used to describe the timing of **ICE** (**I**nternal **C**ombustion **E**ngine) vehicles is not applicable to electric motors. In order to change the timing, you may simply loosen 4 bolts and rotate the bell housing in the direction you desire to advance the timing from the neutral position. All of our motor cases are stamped with "CW" "N" and "CCW" - you can determine the advance state by seeing which commutator **end bell bolt** is aligned with the letters stamped in the case. **THE TERMINAL STUDS SHOULD NOT BE USED TO DETERMINE POSITION OF THE END BELL!**

11. **How can I order** ***AmP*** ™, **and** ***WarP*** ™ **Motors?**

    AmP ™, **and WarP** ™ motors may only be ordered through an Authorized Motor Dealer. A list of Dealers is available on our web page at http://www.go-ev.com

12. **What if I need something other than the "standard" motor?**

NetGain Motors, Inc. will work with our motor manufacturers in order to ascertain your specific needs and develop a motor to meet your needs. Custom motor options, such as special materials, components, shaft splining, special composition brushes, or other variances from standard configurations are available at an additional cost. We also have some motor models that we do not advertise (such as a Sep-Ex AmP 9™). Additionally we make many private label OEM motors. Though we cannot sell these motors to anyone other than the OEMs, the designs may be similar to others needs and can keep the cost of a design within reason. Contact **NetGain Motors, Inc.** with your needs and we can provide a quote.

13. Where can I get replacement parts for my motor?

Replacement parts and components can be ordered through any Authorized Motor Dealer or directly from **NetGain Motors, Inc.**.

14. Will an alternator, generator, windmill or solar panels on my vehicle keep the battery charged?

In brief: "NO"! We receive this question on almost a daily basis! If you figure out a method of actually getting more energy out of something than you put into it – please let us know immediately! To date, no one has figured out how to accomplish this feat – and though you aren't going to receive a ticket for trying, there are certain laws that you would be in violation of. Though windmills and solar cells may certainly be used to help charge batteries, most of the motors we sell are for use in vehicles that can draw between 340,000 watts (for a short time), and 15,000+ watts at highway speeds. If you have the time and plenty of sunlight and wind, these resources could certainly replace at least some of the energy consumed – just not as fast as people generally use it, or as quickly as you may want.

15. Can I use your motors in marine applications?

Certainly, but don't submerge them, and protect them from saltwater. Also, pay particular attention to previous questions. It is extremely difficult to create a watercraft with 10-12 hours worth of wide-open power with generally available battery technology.

16. What are the two wires that come out of the motor case and how do I use them?

These wires are connected to a normally closed 120C thermal switch. On 11” and 13” diameter motors a 150C thermal switch is used. This switch is used to determine whether a motor is nearing a temperature that could cause internal damage to the motor. Some people refer to this switch as a “nuisance switch”. We do not suggest that this switch be used to automatically disable the motor if a heat condition arises as circumstances may require driving the vehicle to a safe area before shutting down. Some people use this switch to keep a contactor open by applying 12-volts to the switch. If the voltage is dropped (by the switch opening), then a light could be lit, or a buzzer sounded to indicate a potential problem exists. The two wires were changed to a recessed plastic connector that has two 1/4” mail spades on newer motors. This makes it extremely easy to connect with. Additionally, the Normally Closed (NC) switch has been replaced with a Normally Open (NO) switch. This also makes it simpler to wire a warning indicator.

17. What is the round black connector on the commutator end bell used for?

Some motor models have been made with a brush wear indicator. If you look carefully into the connector you will see that the round black connector actually accepts flat, female, tab connectors. When the brushes wear to a point where the brush wear indicator wire touches the commutator, **a voltage equal to the commutator voltage will be fed through the brush wear indicator connector**. As this could be a high voltage, appropriate care should be given if this connector is used. Once the brushes wear to the

point where the wire touches the commutator surface it is necessary to replace the brushes quickly or damage to the commutator could occur from the indicator wire. This feature has been removed from most motors as it was difficult to use with the pack voltages of typical EVs.

18. What are *TransWarP* ™ Motors?

TransWarP ™ motors are not a motor with a transmission. The Drive End (DE) of the ***TransWarP*** ™ motors have a 1.375", 32-tooth, involute splined shaft that matches a Chevrolet Turbo 400 (T400) transmission output shaft. The drive end bell has been pre-drilled to accept an optional "shorty" T400 tail-shaft housing. The output shaft accepts an optional industry standard 1350 series slip-yoke for easy connection to almost any manufacturers drive-shaft (with matching 1350 series yoke. The commutator end shaft has also been increased in size to 1.125" with a 1/4" key-way. This allows easy coupling of ***WarP*** ™ motors to ***TransWarP*** ™ motors . These motors were designed to be part of the ***EMIS*** ™ System which was also available from **NetGain Motors, Inc.** You can couple a ***WarP*** ™ motor to a ***TransWarP*** ™ motor of the same size for direct drive applications.

19. Can I direct drive my vehicle using your *TransWarP* ™ Motors?

Our motors like to spin 2000-4000 RPMs. Running the motors at very low RPMs will generally draw significant amperage and not allow the fan to cool the motor. Direct drive works well in racing applications, however it is not the best choice for a daily street driven vehicle. The generally accepted rule of thumb is this: Direct drive will require twice the motor and twice the controller of vehicle with a transmission. This means you would have to use a ***WarP 9*** ™ coupled to a ***TransWarP 9*** ™in an application where a single ***WarP 9*** ™would normally suffice if a transmission was used. Additionally, if a single **Zilla 1K** controller could have been used, you will need a **Zilla 2K** for a direct drive application. Additionally, you must force cool air into direct drive motors if the normal RPMs of the driven vehicle are below 2000 RPMs.

20. How do Volts and Amps affect a motors performance?

Volts=RPMs in an almost linear manner. If you double the voltage you will double the RPMs of the motor. Usually, RPMs increase just slightly more than double as most losses are fixed. You will notice that the performance graphs for our motors are all at 72 Volts. If you plan on running at 144 volts you can simply multiply the RPMs by 2. Amps=Torque. Torque will remain constant if the amperage does not change, regardless of the RPMs. If you look at our 72 Volt graphs and find a ft. lbs. of torque and the amps required to produce that torque, you can simply double the RPMs if you are planning to run at 144 volts, - the torque will be produced at twice the RPMs if the amperage doesn't change. If you increase the Amps, the torque will increase, but in a non-linear manner that is difficult to extrapolate. If you increase the voltage you will basically extend the torque curve of the motor.

21. What voltage and amperage should I run at?

Your budget and performance expectations will normally be the deciding factor, but generally speaking, for a daily driver vehicle, you should consider a voltage between 120 and 156 volts to the motor armature. Motors should never see more than 170 volts to the armature (except when prepared for racing). However, the battery pack voltage should be as high as the controller will allow if using lead-acid batteries. You should generally have a higher pack voltage (ideally) than the motor voltage due to a condition referred to as "voltage sag". When most lead-acid batteries are requested by the controller to deliver 1000-2000 Amps to the motor, the battery voltage can easily sag to 5-5.5 volts per battery (on 12 Volt batteries). Lead-acid batteries have been known to explode during racing applications from heavy

discharges – a credit to the **Zilla** controllers! However, if the voltage of a 12 volt Pb A battery sags to 6 volts, the motor may only see ½ the voltage you intended, and consequently only spin at ½ the RPMs you thought it should! It's generally not the motor that is the reason for poor EV performance, it is more often related to the batteries or controller. (assuming the motor selected is appropriate for the vehicle...)

22. What motor controller should I use with these motors?

For many years the only controller that was **ever** recommended in a pure electric vehicle application by **NetGain Motors, Inc.** were the **Zilla** Controllers from http://www.cafeelectric.com! The Zilla is still available and is still a top-notch controller. Two more recently developed controllers are the **WarP-Drive**™ controllers manufactured by ngcontrols.com, and the **Soliton 1** by evnetics.com. Both of these controllers are excellent choices as well. You may certainly use other controllers, such as the ever popular **Curtis 1231C**, **Alltrax**, **Sevcon**, **Raptors**, **Synkromotive**, and **MaxForcer** – just to name a few of the more popular and highly regarded EV controllers. Your budget and vehicle performance expectations will be heavily impacted by the controller decision you make.

23. How much power can these motors produce?

Series wound DC motors, such as these, are renowned for the massive torque they produce from 0 RPM. These motors will suck every AMP the controller can deliver in order to try and start the armature spinning. Though our motors are regularly abused by **Zilla** controllers delivering 1000-2000 Amps, or Soliton Shiva capable of greater than 3,500 Amps for brief periods, the 9" motors (and 11HV) are actually rated at 450 Amps for 5 minutes, 225 Amps for 1 hour, and 190 Amps continuous duty. The normal 11" motors are rated at 500 Amps for 5 minutes, 250 Amps for 1 hour, and 200 Amps continuous. We believe these are conservative ratings. The difference in the variously sized motors is the amount of torque and RPM at which the torque will be delivered. If the ratings of a single motor are exceeded, you can divide the figures in ~½ and use multiple motors. There are additional losses of around 8-10% when using dual motors.

24. Where can I obtain an adapter plate made for my vehicles transmission?

Many ***AmP*** ™, and ***WarP*** ™ motor dealers specialize in making transmission adapter plates, as well as providing the other components used in EV conversions. Our **Authorized Motor Dealers** are listed on our web-site at http://www.go-ev.com/dealers.html. You can check the annotations in each Dealers listing to locate the best match for your specific needs. Some **Authorized Motor Dealers** are capable of making adapters that are not listed on their web sites, so be sure to work with one of our **Authorized Motor Dealers** for further information and advice.

25. Can I run the motors at 10,000 RPMs?

With no load and high voltage these motors can spin to excessive RPMs **EXTREMELY** quickly! The motors should ONLY be spun at no load with a maximum of 12 volts applied. The bearings are rated to ~14,000 RPMs, however we do not recommend running these motors beyond 5,500 RPMs (7,800 RPM for the 7" motors). For short duration (i.e. drag racing) the motors have been known to approach 10,000 RPMs, but this is strongly discouraged! If high RPMs are an essential requirement of your application you should consider requesting Kevlar banding and other optional modifications (belly banding) that can be performed at the factory or by a few of our **Authorized Motor Dealers**. It is extremely dangerous to run these motors at high RPMs without shielding that can withstand a possible commutator explosion. World records have been set with these motors never exceeding 3,400 RPMs by gearing them properly. If extremely high RPMs are required on a normal basis a more appropriate motor design should be

considered.

26. Where can I get additional assistance with my conversion?

An excellent resource is your local chapter of the Electric Auto Association. These groups have been doing conversions to pure electric for 40+ years and have extensive knowledge. Some of the Members of the EAA are world renown for their abilities. There are numerous books available, (i.e. ***Build Your Own Electric Vehicle*** by Seth Leithman and Bob Brandt or ***ICE FREE*** by John Hardy) and most of our **Authorized Motor Dealers** are willing to discuss your project with you and offer guidance advice at no cost. There is also a very active discussion group on the Internet called the EVDL (http://www.evdl.org/index.html) and the DIY forums (http://www.diyelectriccar.com/forums/). Our **Authorized Motor Dealers** are some of the best resources in the world. They have generally completed numerous conversions and will work with you to supply parts and insight into a vehicle conversion, as well as supplying you with the various components you'll need.

27. What is the EVDL and how do I subscribe?

The **EVDL** is the **E**lectric **V**ehicle **D**iscussion **L**ist. You can find all the details needed to subscribe and view the archives at: http://www.evdl.org/. You might also be interested in what other people have by checking out: http://www.evalbum.com/

28. What components do I need to make an electric vehicle?

You will obviously need an electric motor. You'll also need a motor controller, and a device to act as the throttle that will signal the motor controller as to the power requested - a 5K potentiometer is by far the most typical method, but the Hall Effect method is a safer/better alternative. You'll also need batteries. A battery charger(s), possibly a battery management system, possibly a transmission adapter plate, battery boxes/enclosures, a DC-to-DC converter, a transmission adapter plate, lots of cable, lugs, contactor[s], connectors, gauges and wiring.

29. What makes a good conversion vehicle?

First pick a vehicle you like that is in good condition. It is not uncommon for people to keep EVs for many years. As the weight of the vehicle will probably increase (I've never seen one that decreased if lead-acid was being used), consider the gross vehicle weight constraints. Choose a lightweight vehicle with strong suspension and brakes - sports cars and small pick-up trucks make ideal candidates. Do not change the ride height of the vehicle, or the ride characteristics. The heavier the vehicle, the more likely you are to be dissatisfied with the range and performance. Small pickup trucks make good candidates, as the batteries can be placed under the bed along the frame rails, and they are designed for carrying additional weight (i.e. Batteries). They also have brakes designed to stop the vehicle with the extra weight you may add.

30. I want to go 300 miles on a charge at 75 miles per hour in my Suburban – okay?

NO! The typical range of a lead-acid EV is 25-50 miles on level terrain – depending upon the batteries and weight of the vehicle. Even with the most advanced Pb A battery chemistry currently available a 300 mile range is beyond current Pb A technology. But, conversions using the various Lithium batteries currently available are claiming 75-150+ mile range. We are headed in the right direction, just not at 300 miles for conversion vehicles yet, though the Tesla Model S claims a range of 306 miles for it's 85 kWh battery pack. The same answer goes for recharging the batteries in 5 minutes – it won't happen for quite

awhile. Tesla claims 58 miles of range per hour of charging and 20-30 minute charging at it Supercharger stations (which are also free for Tesla owners to charge at!) The PulsaR™ and QuasaR™ Power Distribution Units (PDU) from ***ngcontrols.com*** have the potential for even faster DC-DC dump charging at a theoretical 150 kW and 300 kW. Though the PDU may have this potential, most battery packs could not withstand this sort of input to the batteries. EV components must be matched for safe operation and usage – consult with a knowledgeable source or contact one of our Authorized Motor Dealers before attempting a potentially dangerous operation on an EV.

31. I want to use a small generator to run the electric motor while I am driving on the highway.

At first this sounds plausible, but using $5.00/gallon fuel (gasoline) to derive $1.00 per gallon fuel (electricity) is only the beginning of the issues surrounding this. Generators are noisy. Most generators are not designed to operate in a mobile environment and fuel can spill from their tanks and create a hazardous situation. If you try to quiet the generator you may reduce its ability to produce electricity. When generators are running they typically produce more pollutants in one hour that 250 hours of driving an ICE. Even in a lightweight vehicle you will require around 150 amps at 144 volts to maintain 60 MPH – that's more than a 21 kW generator!

If the question is “Trains do it why can't a car?”. The simple answer is that trains run level, and straight as much as possible, with few stops, at a constant speed, and cost millions of dollars. Trains are not concerned about their 0-60 MPH time, or merging with traffic. It only takes a small fraction of the power needed to obtain a desired speed that it takes to maintain the desired speed. Additionally, steel wheels on steel tracks offer $1/50^{th}$ of the rolling resistance of rubber on concrete. A typical EV will use 144 Volts and 500 to 1000 Amps to get started from a dead stop. This is 144 kW of power! This would require a VERY large generator – probably larger than the EV itself, and probably requiring more fuel than the original ICE vehicle. My suggestion is that if you really want to attempt this that you only use a generator when the vehicle is parked and not in motion.

32. Can I use capacitors to power the vehicle?

Probably not entirely. Though capacitors offer very high power density, their energy densities are very low (the opposite of fuel cells). Super-capacitors (aqueous based) and ultra-capacitors (organic based) usually become a slave to the batteries. There is potential for the use of capacitors in EVs, particularly when used with re-gen braking, but re-gen braking should not be done with series wound DC motors. The use of capacitors might be beneficial in obtaining a speed, but probably doesn't make much sense to use them to maintain speed. If a DC-to-DC converter were used between a battery pack and the capacitors they might prove to be an excellent addition to an EV. See: http://www.powershow.com/view1/26cee4-ZDc1Z/Hybrid_Advanced_Power_SourcesHAPS_Project_Highlight_VTB_Annual_Review_2002_powerpoint_ppt_presentation

33. Do I really need a transmission?

Whether you need a transmission depends upon many factors. The short answer is “YES”, but depending upon the vehicle, there are instances where no transmission may be required. For instance, if you are planning on just racing the vehicle and not driving it on the street, then you may not need a transmission. But, the transmission can be used to keep the vehicle in its power-band and thus improve the vehicles performance. If the vehicle is extremely lightweight you may also consider not using a transmission. But, once again, there are caveats. The motors normally enjoy spinning 2,000 to 3,000 RPMs. Spinning the motor slower may not provide enough ventilation to the motor, causing it to run hot. Additionally,

very low RPMs may cause the motor to use more amperage and run hotter. A forced-air cover-band is highly recommended along with an external blower than can force cool air into the motor if the motor is going to be run at low RPMs for considerable amounts of time.

The use of a transmission will normally allow you to achieve far better performance and reduce the risks of motor damage due to poor cooling or high amperage. And, a transmission may also provide two other important items for you to consider beyond the gearing advantages:

I. A transmission can act as a mechanical safety disconnect! In case of an emergency the clutch may be depressed, or the transmission shifted to neutral. These motors can be extremely powerful, and brakes alone may not be enough to stop a vehicle if the motor is applying force.

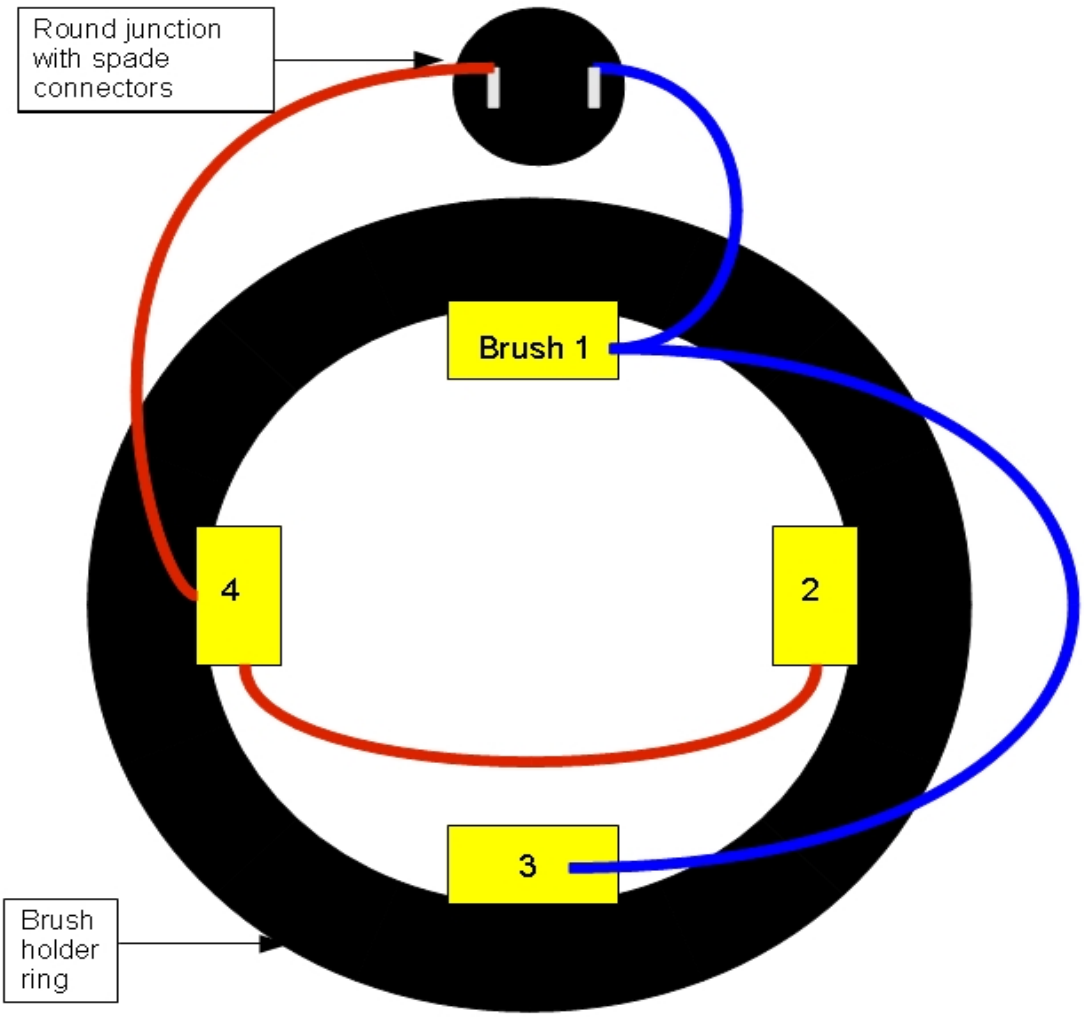
II. A transmission can be used to park the vehicle. Some automatic transmissions have a locking feature (Park) that will keep the transmission from turning – and thus the car from moving if it is on an incline. In an ICE vehicle you always have the engine compression, emergency brakes and transmission (in Park) to keep the vehicle from moving on an incline. In an EV you should maintain a parking brake, but the motor will spin freely, so having a transmission that locks could be a benefit.

34. Should I keep the clutch?

The EV community has always been split on this topic. Certainly it is easier to eliminate the clutch, and the electric motors normally have enough power so that a vehicle can start in 3rd gear without the use of a clutch. But, I personally prefer keeping the clutch If starting on an incline without a clutch, the motor can be required to produce a lot of torque (draw a lot of amperage) depending upon the gear you start in. By using a clutch, it is easier on the motor as you can raise the RPMs and gradually get the vehicle moving. Keeping the clutch also makes it easier to shift gears. The EV community is split 50/50 on whether to keep the clutch. Be aware that if you keep the clutch and insist on driving it like an automatic (i.e. starting in 3rd gear) that it most likely you will burn up your clutch if you make repeated fast starts.

™

Brush wear indicators on WarP Motors



Circuit is completed when brush sensor wire 1 or 3 AND brush wear sensor 2 OR 4 make contact with the armature. Armature voltage will then be present at the connector.

NOTES