



10-001012 TAC2 OEM Installation Instructions

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NAVITAS VEHICLE SYSTEMS LTD

Contents

1. Introduction	2
2. Best Practices	3
2.1. Speed Control	3
2.2. Hill Descent	3
2.3. Low Battery Warning	3
2.4. Heavy Duty Usage	3
2.5. Warnings	4
2.6. Maintenance	4
3. Safety Precaution	5
4. Technical Specifications	7
4.1. HARDWARE # 10-001012	7
4.2. Output Specification	8
4.3. Output Specification	8
4.4. Connector Layout	9
4.5. Wiring Diagram	10
4.6. Pin Definitions	11
4.7. Terminal Posts	13
4.8. Dimensions and Weight	13
5. Mechanical Drawing	14
6. Installation	15
6.1. Mounting Considerations	15
6.2. Minimum Wire Size Recommendation:	15
7. Navitas Dashboard App	16
8. Warranty	17

1. Introduction

All instructions provided in this manual should be strictly complied with. The purpose of this document is to provide the user with the information necessary to utilise and install the described product properly.

The supplied installation kit is equipped with our powerful TAC2 AC motor controller. Every component has been selected and designed with precision, ensuring that your conversion is seamless, and your vehicle will be reliable for years to come.

- The owner, and all vehicle operators **MUST** read and understand all warnings and instructions in the Vehicle Owner's Manual. The owner of the vehicle assumes all liability for accidents, injuries, or damages if the warnings and instructions are not followed.
- **Navitas Vehicle Systems Ltd.** assumes no responsibility for errors or omissions in this manual, nor for liability or damages resulting from the use of the information contained herein. In the event this manual is lost or damaged, please contact your local dealer for a replacement.
- **Navitas Vehicle Systems Ltd.** reserves the right to make changes to the controller, its parts, accessories, labeling, or instructions without any obligation to apply these changes to units previously sold.

** Products and specifications are subject to change without notice or obligation.*

2. Best Practices

2.1. Speed Control

1. Use Only Necessary Speed:

- Utilize the speed you need. Adjust speed settings in the [Dashboard App](#) to the minimum practical speed necessary for your application to conserve battery power and extend the driving range.

2. Control Maximum Cruising Speed:

- Use the [Dashboard App](#) to set your maximum cruising speed. Lowering the speed increases the controller's efficiency, thereby enhancing the motor's operating efficiency.

3. Minimize Hard Acceleration:

- Avoid rapid acceleration, as it demands high in-rush currents from the battery pack, leading to decreased range and increased wear on mechanical systems.

2.2. Hill Descent

1. Utilize Regenerative Braking:

- Use regenerative braking to slow down during hill descent. This process puts energy back into the battery, prolongs brake life, and reduces the risk of losing traction.

2. Limit Downhill Speed with Full Lithium Batteries:

- Avoid high speeds downhill when the lithium battery is fully charged to prevent the Battery Management System (BMS) from shutting down due to overcharging.

2.3. Low Battery Warning

1. Responding to Battery Discharge Warning (3-1 Flash):

- The controller will reduce power to protect the motor. Cycling the key resets full power for 1 minute, but repeated resets can harm the batteries. Recharge batteries promptly.

2.4. Heavy Duty Usage

1. Thermal Protection:

- Both the controller and motor have thermal protection. If either starts to overheat, performance will be limited until temperatures drop.

2.5. Warnings

1. Monitor Wiring Temperatures:

- Always check motor and battery wiring temperatures after adjusting controller settings, especially at higher speeds.

2. Regenerative Braking with Full Battery Pack:

- If the battery pack is full, regenerative braking may be less effective as the controller has limited capacity to store excess energy.

2.6. Maintenance

1. Monthly Torque Check:

- 1.1. Check the torque of wire connections monthly to prevent loosening, overheating, and warranty voiding.

2. Proper Washer Placement:

- 2.1. Do not place flat or lock washers between the controller post and the cable lug. Washers should be on top of the cable lug and under the bolt head for optimal electrical connection.

3. Dielectric Grease Application:

- 3.1. Apply a small amount of dielectric grease to connections if the vehicle operates in damp or wet conditions to keep moisture out of connectors.

3. Safety Precaution

We recommend reading this instruction sheet thoroughly and carefully.



DANGER

FAILURE to follow the WARNINGS below can damage the Vehicle and/or cause SERIOUS INJURY OR DEATH!

MAKE SURE TO READ and UNDERSTAND the OWNER'S INSTALLATION and SERVICE MANUAL and ALL WARNING LABELS with this upgrade.

Make sure to also Read, Understand, and follow the Vehicle's OWNER'S MANUAL and ALL INSTRUCTIONS and WARNING LABELS.

- Always proceed with caution. Keep speed low and do not drive faster than conditions permit. Terrain, conditions, and the operator's skill will determine a safe speed. Avoid sharp turns and do not accelerate quickly when turning as this can cause the vehicle to slide sideways or skid out of control. Abrupt manoeuvres or aggressive driving can cause a rollover, even on flat open areas.

- Modifying motor controller parameters may change vehicle acceleration, braking and top speed behavior. Please verify vehicle performance before use and obey federal, county, and municipal bylaws and regulations.
- Product use is for golf car and Low Speed Vehicle (LSV) market application and may operate at speeds Up to 25 MPH. Factory settings on controller have been set using: 18-inch diameter tires.
- Operators/Users of Navitas golf car and LSV equipped products must follow published golf car & LSV federal, state, county & municipal bylaws & regulations issued for your use area. For operation/use beyond golf car & LSV regulations/ guidelines, full liability is assumed by operators/users.
- Do not leave children or pets unattended in or near the vehicle. Always look behind you before and while backing up.
- Drive with wheels straight when going up and down hills. Slow down and use brakes when going down hills.
- Never drive on hills with a slope greater than 15 degrees.
- Do not drive through fast flowing water or water above the floor of the vehicle.
- If you must cross shallow water, make sure to stop and inspect the area for sudden drop-offs, large rocks, or slippery surfaces. Always proceed with caution or choose a safer route.
- When towing this vehicle make sure to release parking brake.
- Never exceed the towing capacity rating as specified by the vehicle manufacturer.
- Reduce speed when towing and allow more room for stopping and turning.
- Never re-wire, by-pass or change the wires, switches, or controller. Contact your dealer if vehicle is not operating correctly.

- Keep the controller and the area around it clean and free of debris. Keep electrical components dry and DO NOT wash with direct stream or power washer.
- Driver must be a minimum of 16 years of age with a current driver's license or be accompanied by a parent or legal guardian when operating the vehicle.
- Do not drive vehicles while influenced by alcohol, medications & drugs as this may/will impair your safe driving use.
- User to verify that golf car & LSV vehicle mechanical brakes are fully functional prior to continued operation of vehicle.
- Do not put flat or lock washers between the controller post and the cable lugs. Washers go between the cable lugs and the bolt head.
- Vehicle & all parts must be serviced by qualified service personnel. For an authorized service location see your local dealer or visit our web site at <http://www.Navitasvs.com>



WEAR EYE PROTECTION!

4. Technical Specifications

4.1. HARDWARE # 10-001012

Product Number	10-001012
Nominal input voltage	36V-72V
Recommended lower voltage limit	18V
Absolute maximum operating voltage	90V
Battery current consumption	Off = 0A Idle < 0.1A Max (est.) = 425A
Phase Current (Peak) 10s	600A
Phase Current (Peak) 30s	600A
Phase Current (Peak) 120s	600A
Phase Current (Peak) Continuous	130A
FET PWM switching frequency range	15kHz
Maximum recommended motor electrical frequency (10000 RPM)	600Hz
Minimum recommended motor phase to phase inductance	20uH
Supported motor types	3-Phase permanent magnet motors. 3 Phase Induction Motors.
Supported motor position sensor types	Encoder, Sine-Cosine
Input capacitance	6mF
Operating ambient temperature range	-20°C to 50°C
Storage temperature range	-40°C to 85°C
Baseplate Thermal cutback	80°C
Baseplate Thermal cutoff	100°C
Ingress protection	IP65
Communication protocols	Standard: Bluetooth LE, CAN
Dielectric withstand production test	1000V

*All specifications are for an ambient temperature of +25°C, unless otherwise specified are subject to change without notice

4.2. Output Specification

TYPE	QUANTITY	NOMINAL OUTPUT	ELECTRICAL LIMITS	
			CURRENT	TRANSIENT VOLTAGE
5V output	1	5V	20mA	5.5V
12V output	1	12V	50mA	12.7V
Low side switches (pins 2,3,4,5,6)	4	PWM	2A	VBAT+
Phases	3	PWM	Maximum motor current	VBAT+

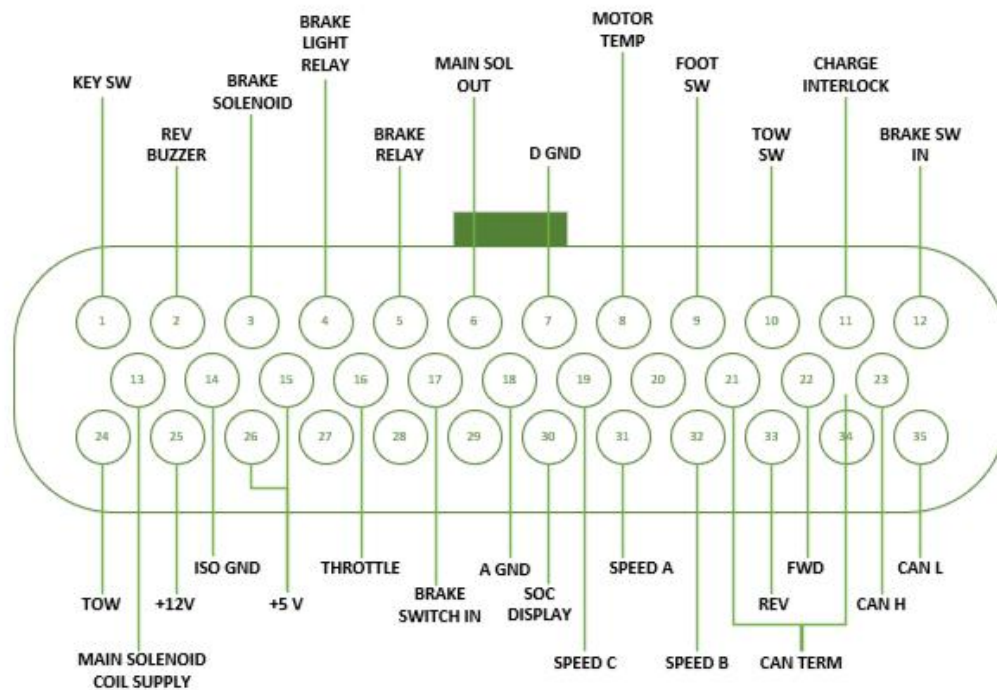
4.3. Output Specification

TYPE	QUANTITY	ELECTRICAL LIMITS	
		LOW	HIGH
Digital Inputs (pins 9,10,11,12,22,33)	6	<1V	>10V
Analog Inputs (pins 16,17)	2	0V	5V
Encoder Inputs (pins 31,32)	2	0.8V	2V
CAN Communications (Isolated) ¹	2	0V	30V Maximum

1. CAN outputs isolated from controller GND. If isolation is not required, ISO GND (MCU Pin 14) should be connected to Digital Ground (MCU Pin 7)

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4.4. Connector Layout



P01: Key In / Logic Power	P19: Speed C In
P02: Reverse Buzzer	P20: na
P03: Brake Solenoid Out	P21: CAN Termination
P04: Brake Light Relay Out	P22: Forward Switch In
P05: Brake Solenoid Out	P23: CANH
P06: Main Solenoid Out	P24: Tow Switch In
P07: Logic Power GND	P25: +12V Out
P08: Motor Temperature In	P26: +5V Out
P09: Foot Switch In	P27: na
P10: Tow Switch In	P28: na
P11: Charger Interlock In	P29: na
P12: Brake Switch In	P30: SOC Display Out
P13: Main Solenoid Coil Supply	P31: Speed A In
P14: Isolated Ground	P32: Speed B In
P15: +5V Out	P33: Reverse Switch In
P16: Throttle In	P34: CAN Termination
P17: Brake Switch In	P35: CANL
P18: Analog GND	

Figure 1 AMPSEAL 776164-1 Connector Layout

4.5. Wiring Diagram

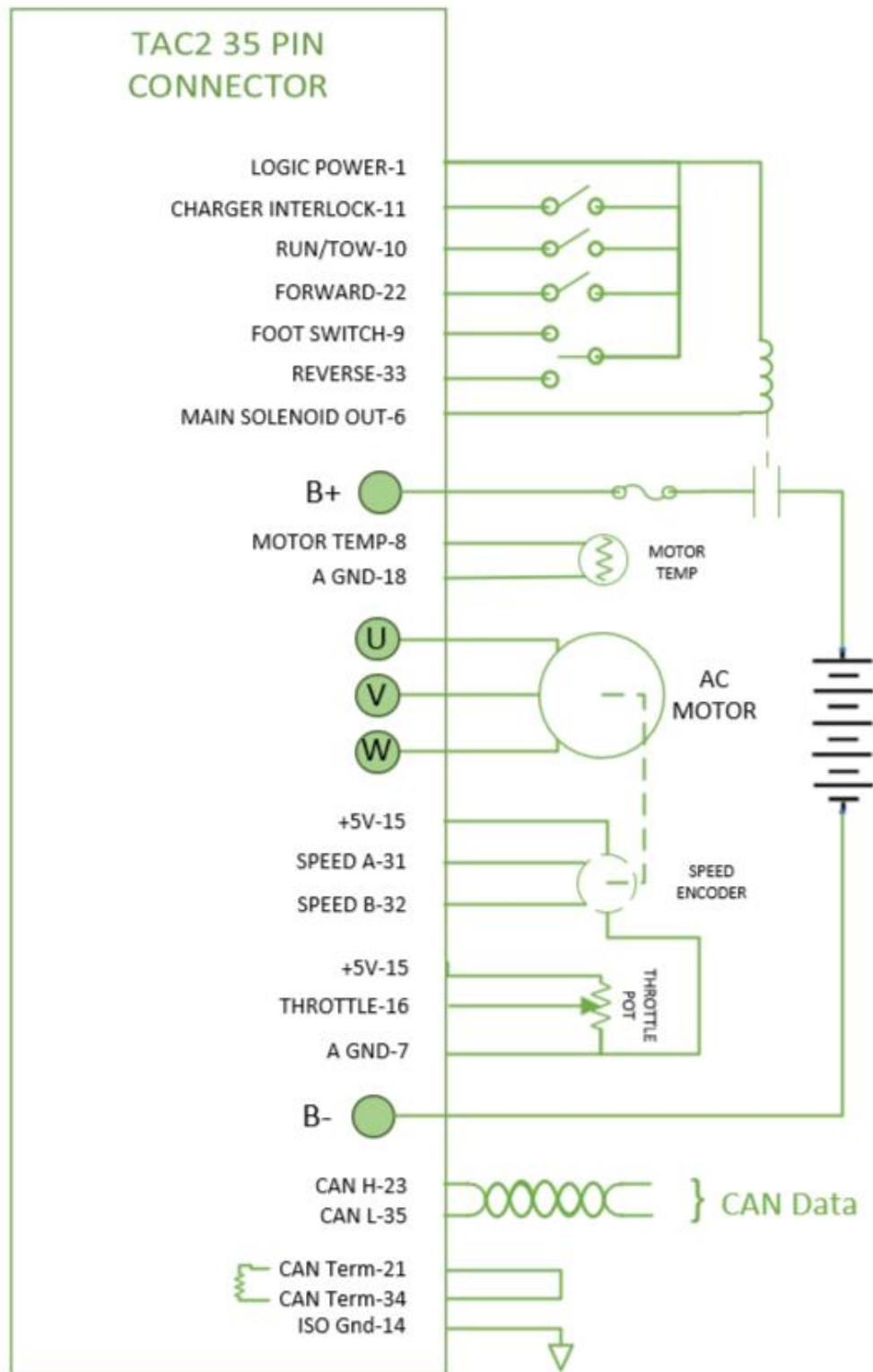


Figure 2 Typical Installation Wiring

4.6. Pin Definitions

PIN	Description	ELECTRICAL LIMITS		SPECIFICATIONS
		CURRENT	TRANSIENT VOLTAGE	
1	Key switch input / Logic power	~90mA	VBAT+	Powers all controller low power electronics including Bluetooth but does not power Motor. -This input is driven by the vehicle key switch when it is not off, F or N or R are on. -B+ is for motor power, B+ is not directly connected internally to this input. This input will precharge internal high-power circuits with limited current before allowing the Main solenoid to close.
2	Reverse buzzer	N/A	0V	Switched to ground. Active when in reverse or for 1 second at power up or pulsed (click sound) if an error is detected.
3	Brake solenoid	N/A	<48V	Some motors include a magnetic brake that is always attached to them.
4	Brake light relay	N/A	0V	Switched to ground. -To activate the relay, this signal switches at high speed to maintain a programmable coil voltage (default 12V). -Actual brake light power is provided through the relays contact pins. This signal is active when the brake pedal signal or brake pedal switch are active.
5	(Brake Solenoid)			
6	Main solenoid	N/A	0V	Switched to ground. Signal switches at high speed to maintain a programmable coil voltage (default 36V). Active by foot switch in combination with turn off timers Resistors and Diodes on the Main Solenoid are not recommended and should be removed.
7	DGND			
8	Motor temperature	N/A	0.36V @ 0C 0.952V @ 120C 1.110V @ 175C	A low voltage input that is converted to temperature by the controller. When motor temperatures exceed 120°C, motor phase currents will be reduced to lower motor temperature.
9	Footswitch	N/A	VBAT+	This input is switched to 48V when the throttle is slightly pressed and before the throttle reaches the 1V start position. The vehicle will not move if this signal is always

				on after power up or is off but the throttle voltage is active.
10	Tow Switch	N/A	VBAT+	When switched to 48V the controller will disengage the parking brake at the time the key is turned on.
11	Charger interlock	Charger Dependant	0V	0V indicate charger is plugged in. Greater than 20V indicates charger is unplugged.
12	Brake switch	N/A	0V	Normally closed switch in the brake pedal assembly which opens and indicates to the controller that the brake pedal has been pressed.
13	Coil Supply			
14	Isolated GND	N/A	N/A	Used for the CAN Isolation circuit.
15	+5V	20mA	+5V	External voltage used to power the speed encoder for the motor and the throttle
16	Throttle	N/A	3.7V	An analog sensor with a sweep of 0 – 5V. - Default Settings: 0.5V pedal is fully off - 1.0V pedal is pressed slightly - 3.7V pedal is fully pressed
17	Brake	N/A	3.7V	An analog sensor with a sweep of 0 – 5V. - Default Settings: 0.5V pedal is fully off - 1.0V pedal is pressed slightly 3.7V pedal is fully pressed
18	DGND			
19	Speed C	N/A	5V	Same as Speed A and Speed B
20	N.C			
21	CAN Termination Option	N/A	N/A	Used with pin 34 to add termination to CAN connections
22	Forward switch	N/A	48V	48V indicates Forward switch is on.
23	CAN P	N/A	5V	
24	(Tow switch)			
25	+12V	N/A	+12V	12V low current supply
26	+5V	N/A	+5V	5V low current supply
27		Reserved		
28	TX			
29	RX			
30	SOC	N/A	4.52V	4.52V @ 100%
31	Speed A	N/A	5V	0 to 5V offset signals which change quickly as vehicle moves. -It will stay either at 0 or 5V if vehicle is stopped

				depending on position. Each signal outputs 64 pulses per revolution of motor. With a 15 to 1 gear ratio this is $15 \times 64 = 960$ pulses per signal per wheel revolution. Because they are offset by 90 the controller can determine $4 \times 960 = 3840$ per wheel revolution.
32	Speed B	N/A	5V	Same as Speed A.
33	Reverse Switch			
34	CAN Termination Option	N/A	N/A	Used with pin 21 to add termination to CAN connections
35	CAN_L	N/A	N/A	

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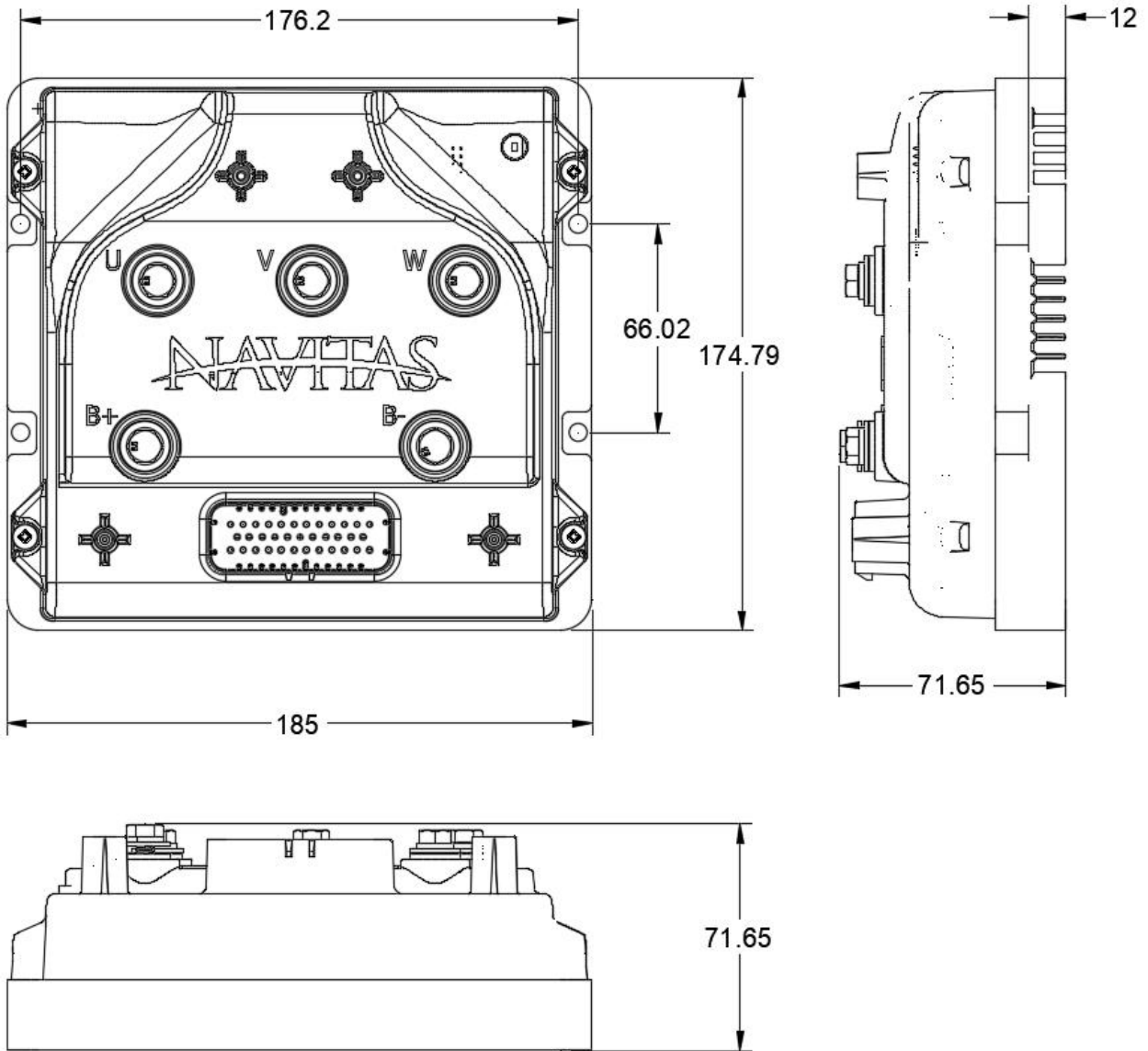
4.7. Terminal Posts

TERMINAL	FUNCTION	TERMINAL THREAD & TORQUE SPECIFICATIONS
U	Phase U/A	M6-1.0mm UNC x 15mm (L) HEX Bolt (Torque 88: in-lbs/ 7.5 ft-lbs/ 10 Nm)
+	VBat+	
V	Phase V/B	
-	VBat-	
W	Phase W/C	Figure 3 Dimensions

4.8. Dimensions and Weight

PRODUCT	L [MM]	W [MM]	H [MM]	WEIGHT [KG]
TAC2 OEM	185.00	174.80	72.00	2.27

5. Mechanical Drawing



6. Installation

Before beginning any work on the vehicle, disconnect the vehicle battery and ensure cables are secured to avoid them inadvertently making contact while working on the vehicle.

6.1. Mounting Considerations

- **Heat Dissipation:** The controller should be mounted to a metal plate for optimal heat dissipation.
- **Vibration:** The controller should be mounted to a solid mounting location
- **Clearance:** Maintain sufficient clearance around the controller to allow access to connections, maintenance, and inspection. Avoid mounting it in confined spaces where heat buildup could occur.
- **Cable Management:** Route power and signal cables away from any sharp edges, heat sources, or moving parts. Proper cable management prevents wear or damage that can cause electrical faults:
 - Strain Relief: Use strain reliefs to secure the cables and prevent undue stress.
 - Bends: Avoid tight bends, kinks, or unnecessary stress on cables to prevent breakage over time.
- **Accessibility:** Mount the controller in an easily accessible location to facilitate future maintenance or troubleshooting without the need to remove other components. This is particularly useful for vehicles that may require frequent inspection, such as fleet vehicles.

6.2. Minimum Wire Size Recommendation:

- For optimal performance and safety, it is recommended to use a minimum of 2 AWG copper wire for all power connections. This ensures the wire can handle the continuous current and peak demands of the system while minimizing voltage drop and heat buildup.
- Make sure to use wire with appropriate insulation rated for the system's operating temperature and environment.

7. Navitas Dashboard App

Download The Navitas Dashboard App

Take charge of your vehicle with the Navitas Dashboard App. Fine-tune your car's performance, access real-time data, receive timely reminders, and more.

<https://navitasvs.com/app>



8. Warranty

Warranty Document #05-000102

Navitas Vehicle Systems Ltd. warrants that the products sold to Customer by Navitas will be free from defect in materials and workmanship as noted below, from the date of manufacturing shipping of the product, subject to the terms and conditions in this Limited Warranty.

1. TSX, TSX2.0, TSX3.0, Separately Excited Models, TPM Permanent Magnet Models, TAC AC Induction Models – 24 months
2. TSE Series Models, PSE Hydraulic Models, CTL Series Models – Lessor of 12 months or 4,000 hours
3. MAC AC Motor – 12 months

If, during the applicable warranty period, (i) Navitas is advised in writing as to a defect in a Navitas product; (ii) such product is returned to a receiving point designated by Navitas; and (iii) an examination of such product discloses to Navitas' reasonable satisfaction that such product is defective and such defect was not caused by accident, abuse, neglect, alteration, improper installation, lightning damage, submersion, short circuits due to improper handling, repair, improper testing or use contrary to any instruction issued by Navitas, Navitas will repair or replace the defective product at no cost to Customer, except for transportation costs. Replacement shall mean furnishing the Customer with a new product equivalent to the defective product. All defective products replaced by Navitas under this warranty shall become the property of Navitas and must be returned to Navitas properly packed to prevent physical damage.

Navitas does not warrant that any product is suitable for use in any particular application. Customer shall be responsible for evaluating the appropriateness of the use of any specific Navitas product for a particular application. Navitas shall be entitled to rely exclusively upon such representation in furnishing any product to Customer.

TSX and TAC Products Application is for Golf Car and LSV Vehicles with speeds of up to of 25MPH. Users must comply with Federal, County and Municipal Bylaws & Regulations when operating vehicles.

Warranty Limitations

The foregoing warranty constitutes Navitas' exclusive Liability and the exclusive remedy of Customer for any breach of or any other nonconformity of the products covered by this warranty. This warranty is exclusive and in lieu of all other warranties. Navitas makes no warranty, expressed or implied or statutory including, without limitation, any warranty of merchantability or fitness for a particular purpose.

No representative, employee, distributor, or dealer of Navitas has the authority to make or imply any warranty, representation, promise or agreement, which in any way varies the terms of this limited warranty.

The Navitas products sold to Customer are intended to be used only in the application specified by Customer to Navitas. Any other use renders the Limited Warranty expressed herein and all implied warranties null & void and same are hereby excluded. Under no circumstances shall Navitas be liable to Customer or any third party for consequential, incidental, indirect, exemplary, special or other damages whether in an action based on contract, tort (including negligence) or any other legal theory, arising out of or related to the products sold to Customer, including but not limited to lost profits or loss of business, even if Navitas is apprised of the likelihood of such damages occurring.

This limited warranty may not be changed, modified, limited, or extended in scope except by a written agreement signed by Navitas and Customer. Except as stated, any purported modification of this limited warranty shall be null and void.

April 2019