Controller ASSY Product Specification

Date:

□Tentative Specification
■Product Specification

Product ID		—
Manufacturer	Product Name	CONTROLLER ASSY, MOTOR DRIVE
Manufacturer	Type	48M350B
Manufacturer	Product ID	Set in
Type		—
Matched Motor		HSLT AQHT4-4101B
Program		Set in
Remark		Specification REV1.0

This Specification is signed according to the prime contract.
This Specification is made in octuplicate (four in Japanese and four in Chinese), and each party holds two copies (in two different languages) after both parties have signed and sealed.
Both Chinese and Japanese versions are official texts, with equal legal effect.

Date
Dongguan Lvtong Golf Sightseeing Vehicles Co., Ltd.

Approval	Review	Undertake

Date
Toyota Tsusho (Shanghai) Co., Ltd.

Approval	Review	Undertake

Date

Toyota Tsusho Corporation

Approval	Review	Undertake

Date
Prepared by: Unit Development Room, Development Department 2, Technical Development Headquarters, Toyota Industries

Approval	Review	Undertake

Change History

Symbol	Change Item	Date	Changed by
	REV1.0 newly prepared	-	-

Table of Contents

Safety Precautions

Please read this *Safety Precautions* and all other notes thoroughly before assembling, wiring and using (operating, maintaining and checking) the product.

Safety precautions in this Specification are divided into two levels: “Warning” and “Caution”.

Warning	Keep away from it, or it may cause death or severe injury risk.
Caution	Keep away from it, or it cause slight or medium injury risk or damage risk.

Caution

The recorded content may also cause serious consequence in some cases.

The warning and caution contents are all important contents which should be strictly observed.

The contents to be observed by users are classified with the following symbols.

Contents to be observed by users

Contents which should not be executed

Contents which must be executed

■Precautions for Use

Warning	
	Never open the cover, or it may cause failure or electric shock.
	Do not touch terminals when powering on, or it may cause electric or misoperation.
	Do not decompose, rebuild or process this product, or it may cause failure, electric shock, fire disaster, or personal injury.
	Do not wire or insert or pull out connector when this product is powered on, or it may cause system damage, fuming or fire disaster. Furthermore, it may also damage built-in program.
	If it’s necessary to touch, please do it 10 minutes after power failure. The internal capacitor will maintain high voltage for a period of time after powering on, which may cause eclectic shock.
	Do not wire, check, insert/pull out connector with wet hands, or it may cause electric shock.
	The motor may generate high voltage when rotating even though the power supply has been cut. Do not touch, or it may cause electric shock.
	Never wash the product with water, or it may cause electric shock or failure.
	Do not use damaged or deformed cover, or it may cause electric or failure.
	Make sure water will not flow into the product during washing, or it may cause electric shock or failure.
	Do not use damaged or deformed radiator, or it may cause electric shock, failure or fire disaster.
	Wire and check 10 minutes after power failure and confirmation of positive and negative voltage by multimeter. The internal capacitor will maintain high voltage for a period of time after powering on, which may cause eclectic shock.
	Wiring and checking should be completed by professional personnel, or it may cause failure or electric shock.
	It should be noted that the terminal board loses water resistance or dust resistance after dismounting of screws and connectors. It may cause electric shock or failure if the terminal board is used with water or dust in it.

Caution	
	Do not apply the voltage or current which is not specified in the Specification to terminals, or it may cause fracture or damage.
	The motor driver will keep in high temperature state for a period of time when powering on and after powering off. Do not touch or it may cause scald.
	Do not tear off or stain the nameplate sticker (the sticker recording manufacturing number, etc.) on the product.
	In order to prevent from the damage caused by static electricity, please get rid of the static electricity on your body before touching the product.
	Please turn off the power of motor driver if the motor drive breaks down, or it may cause fire disaster.
	Please remove the dust and stopper on the radiator fin at regular time, or it may cause fire disaster.
	Please remove the foreign matter and dust on the cover, or it may cause electric shock or failure.

■ Matching and usage

Warning	
	Do not use the motor and rotation not specified by the Specification, or it may cause failure or personal injury resulting from accidental action.
	Do not connect more motors to the motor driver, or it may cause failure or personal injury resulting from accidental action.
	Please do install fuse between the power supply (battery, etc.) and the motor driver, or it may cause fire disaster or failure.
	Although output command signal has been shut off, output may not be stopped in certain functional setting states. Please equip emergency stop switch circuit separately.
	Please set standby safety devices, such as emergency brake, so as to ensure the machine will not be in danger when shutting down.

Caution	
	Do not install the product at the place with splashed foreign matters, or it may cause failure.
	Do not install the product at the place with splashed water, or it may cause failure.
	Do not install the product on or in the vicinity of combustibles, or it may cause fire disaster.
	Please use the wire with same current value of power-on current value. Small allowable current value of wire may cause failure.
	Please conduct check and trail run before using the product which was stored for a long time, or it may cause failure.
	Parameter setting should be done after sufficient confirmation of the mechanical property of the motor, or it may cause failure.
	The product may still in high voltage and high temperature state when powering on or after powering off. Please take safety measures, such as installing a cover, to prevent form touching with hands or spare parts.

■Handling, installation and storage

Warning	
	Make sure power supplies, such as battery connector, are disconnected before installation and dismounting motor driver, or it may cause electric shock.

Caution	
	Do not install or run damaged product or it may cause failure or personal injury.
	Do not hold the cover when handling the product or it may cause product falling down or failure.
	Do not stand on the product or place heavy articles on the product, or it may cause failure or personal injury.
	Prevent conductive articles or consumables from getting into the motor driver, or it may cause fire disaster.
	Do not make the product fall down or impacted, or it may cause failure.
	Please handle the product by correct method according to its weight, or it may cause personal injury.
	Please fix up the product at the place with sufficient loading capacity, or it may cause product falling down or personal injury.
	Please store the product in the environment which complies with the Specification, or it may cause failure.

■Wiring

Warning	
	Wiring should be done after the main body is installed, or it may cause electric shock or personal injury.

Caution	
	Do not misplug terminals, or it cause fracture or damage.
	Please connect the terminals (U, V and W) on the output side of motor driver correctly, or it may cause personal injury due to accidental actions, such as motor reversal.
	Please connect rotation sensor of motor driver correctly, or it may cause personal injury due to accidental actions, such as motor reversal.
	Use the screws recommended by the Specification and tighten at the specified torque when connecting cable to terminal board. Improper installation may cause heating of cable and terminal board due to bad contact, and even cause fire disaster and personal injury.

■Trail run and debugging

Caution	
	Do not revise programs or parameters when driving, or it may cause personal injury due to accidental action.
	Do not put off the power or pull out communication cable when revising programs or parameters, or it may cause data damage or personal injury due to accidental action.
	Please consider the contents sufficient before setting parameter values, or it may cause instability or

	personal injury due to accidental action.
	Parameter values could be set for 5,000 times. If setting for more than 5,000 times, it may cause failure.

■Exception handling

Caution	
	The blowout of the fuse on the machine side may be caused by wiring abnormity, motor driver failure or motor failure. Please change fuse after the problem is solved.
	When running the protection function, please refer to the diagnosis recorded in the Specification, find the reason and run again.

■Check and maintenance

Caution	
	Do not clean with organic solvents, or it may cause deformation or performance degeneration.
	Do not conduct insulation resistance test to the connector of motor driver, or it may cause failure.
	In order to prevent from secondary disaster caused by the failure arising from degeneration of spare parts of motor driver, it is recommended to change every ten years in general operating environment.

■Abandon

Caution	
	Please consider *LPEUR* and *Waste Disposal* and *Cleaning Up Law*.
	Local laws should be observed preferentially when abandoning the product in other countries excepting Japan.

■Contents of warning labels on the product

Improper use, maintenance and check operations are very dangerous and may cause human injury and machine damage.

Therefore, please start use, maintenance and check operations after sufficiently understand the contents of warning labels on the product.

Label of Warning for Electric Shock

Designated Label for Tightening Torque

Label for Safety Precaution

This *Safety Precautions* is the updated as of November 2012.

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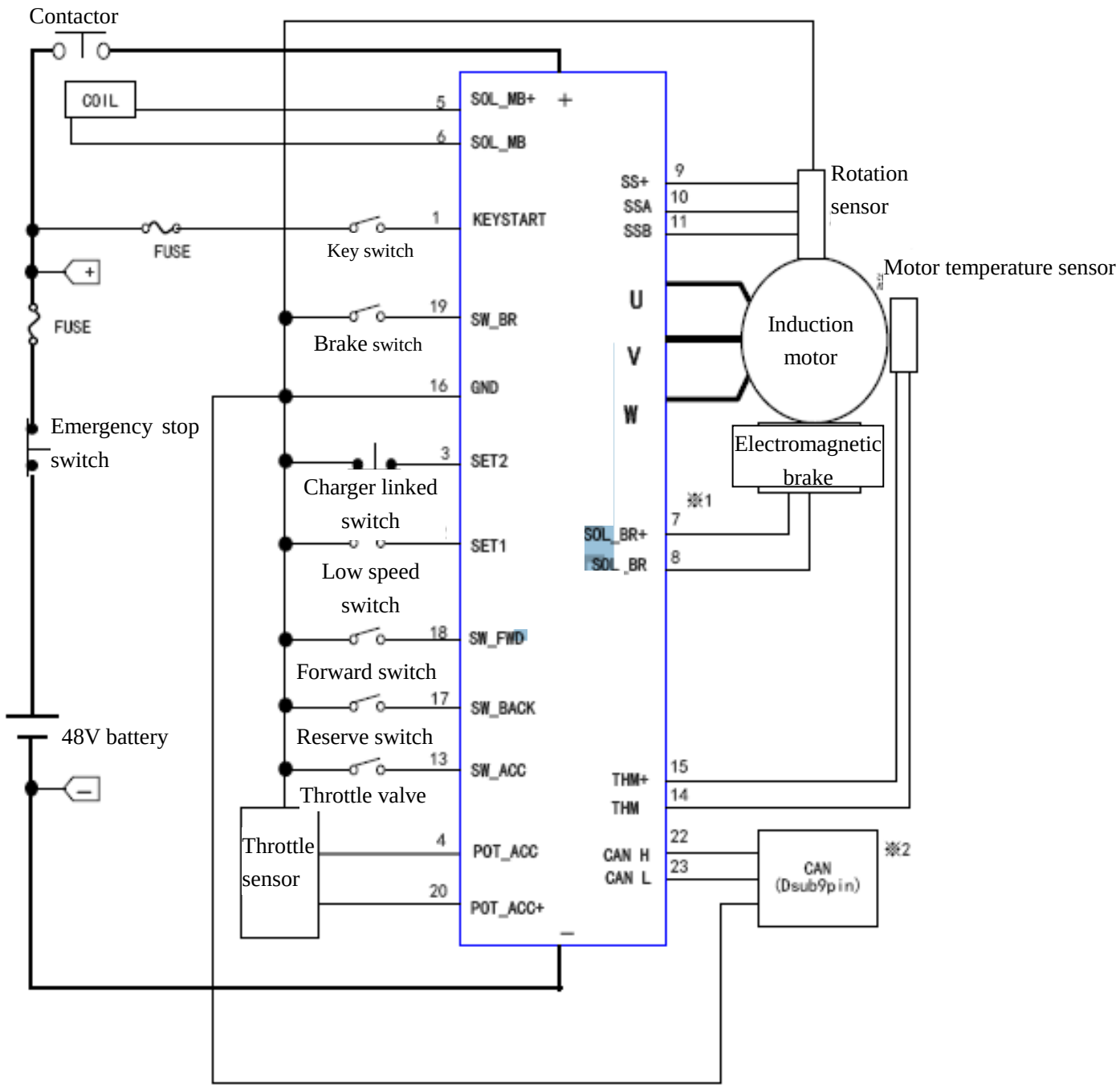
1. Introduction

The controller which controls AC motor (AC induction motor) according to the input signal from switch and position sensor.

2. Recommended wiring diagram



※ Example of recommended circuit

This connection specification can guarantee normal action.

This controller only guarantees the motor actions recorded on the cover.

※1 The device which is connected to Pin 7 and 8 could be changed with an alarm apparatus or electromagnetic brake.

※2 CAN communication is only used for the tools and service of the company.

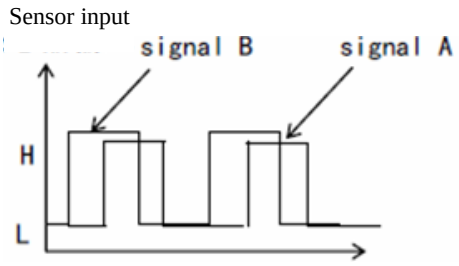
3. Hardware specifications

3.1 General specifications

No.	Item	Specification	Remark
3-1-1	Product name	CONTROLLER ASSY, MOTOR DRIVE	
3-1-2	Type	48M350B	Please refer to the type recorded on the cover
3-1-3	Rated input voltage	48V	
3-1-4	Maximum input current	350Arms	Please refer to the type recorded on the cover
3-1-5	Rated output current	2min rated output current: 350Arms Main body ambient temperature: 25℃ 60min rated output current: 150Arms Main body ambient temperature: 40℃	Please refer to the type recorded on the cover Cooling condition: as per “No. 3-1-14”
3-1-6	Output frequency	0~200Hz	
3-1-7	Action voltage range	20~63V	Motor control voltage range: as per “3-3-2” and “3-3-3”
3-1-8	Insulation strength	500VAC 50/60Hz 1min	
3-1-9	Insulation resistance	Above 10MΩ 500VDC	
3-1-10	Operating temperature range (main body ambient temperature)	-40℃ ~ 55℃	
3-1-11	Storage temperature range	-40℃ ~ 80℃, ambient humidity 95%	
3-1-12	Humidity range of operating environment	30%~95%RH	
3-1-13	Cooling mode	Air cooling	
3-1-14	Cooling condition	Use after the flat bottom temperature is below 80℃	
3-1-15	Tighten torque	14Nm±3Nm	
3-1-16	Weight	Below 2.2kg	
3-1-17	Dimension	210mm×110mm× H 85mm	Please refer to the type recorded on the cover
3-1-18	Dust tightness Water resistance	IP65	
3-1-19	Matching specification	EN1175, UL583 (E, ES) (Safety-Electrical Requirements for Industrial Vehicles) However, the acquisition of certification should be considered separately.	
3-1-20	Environment loading matter	-	Use limit is specified separately
3-1-21	Nameplate	Manufacturing type, manufacturing number, marked with (product) serial number and identification code.	

3. Hardware specifications

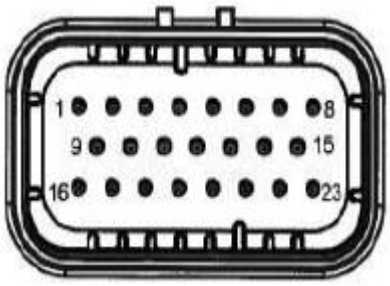
3.2 Input and output specifications

No.	Item	Specification	Remark
3-2-1	Basic specification of KETSTART	• Reversed polarity protection • Loss below 15W (input voltage DC 20V~63V)	Pin No.1
3-2-2	Currant condition of KETSTART	Inrush current when the KETSTART is on Below 4.5A (when the battery voltage is 48V)	
3-2-3	Maximum supply current of rotation sensor I/F	10V~16V 50mA I/F protection when the rotation sensor is shorted	Pin No.9
3-2-4	Detection voltage of rotation sensor I/F	L: below 1.5V H: above 3.0V	Pin No.10, 11
3-2-5	Signal phase of rotation sensor	90 °±20 °	Pin No.10, 11
3-2-6	Phase sequence of rotation sensor	Motor output sequence: U-V-W 	
3-2-7	Pulse count of rotation sensor	64 pulses/rotation	
3-2-8	-	-	
3-2-9	Temperature sensor Type of motor	Manufacturer: Philips KTY84-130	Pin No.14, 15

3. Hardware specifications

3.2 Input and output specifications

View of patches of controller connector (with connector locking part upside, give pin numbers as per the numbers in the diagram below)



Controller on the other side: use AMPSEAL type 770680-1 made by Tyco Electronics

Pin No.	|Description	Usage	Voltage	Current
1	KEYSTART	Key switch	48V	500mA (4.5A when inrushing)
2	SET1	Low speed switch	0~5V	2mA
3	SET2	Linked switch of connector	0~5V	2mA
4	POT_ACC	Throttle sensor	0~5V	1mA
5	SOL_MB+	Contactor +	48V	Output 0.6A
6	SOL_MB	Contactor	0~48V	PWM drive (Duty 0~100%) 0.6A
7	SOL_BR	Electromagnetic brake or alarm apparatus	0~48V	PWM drive (Duty 0~100%) 0.6A
8	SOL_BR+	Electromagnetic brake or alarm apparatus +	48V	Output 0.6A
9	SS+	Power supply of rotation sensor	15V	8~50mA
10	SSA	Rotation sensor A	0~5V	0~15mA
11	SSB	Rotation sensor B	0~5V	0~15mA
12	SW_PB	-	0~5V	2mA
13	SW_ACC	Throttle valve	0~5V	2mA
14	THM	Temperature sensor of motor	0~5V	5mA
15	THM+	Temperature sensor of motor +	About 5V	5mA
16	GND	GND	0V	80mA
17	SW_BACK	Reverse switch	0~5V	2mA
18	SW_FWD	Forward switch	0~5V	2mA
19	SW_BR	Brake switch	0~5V	2mA
20	POT_ACC+	Throttle sensor +	About 5V	5mA
21	SS-	-	-	-
22	CANH	CAN communication ※	0~5V	-
23	CANL	CAN communication ※	0~5V	-

※ CAN communication is only used for the tools and service of the company.

3. Hardware specifications

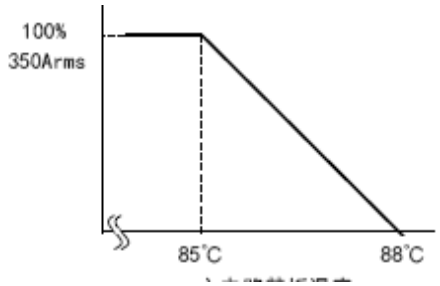
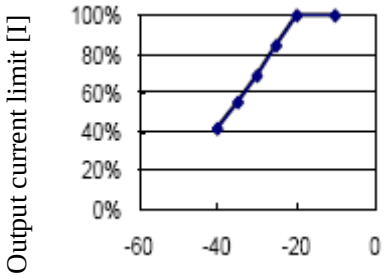
3.3 Reliability test

No.	Item	Specification	Remark
3-3-1	High temperature action (thermostability)	The controller should act normally when being placed for 100Hr (power-on state) with the ambient temperature of 85℃.	
3-3-2	High temperature placement (thermostability)	The controller should act normally when being placed for 80Hr (non power-on state) with the ambient temperature of 80℃.	
3-3-3	Low temperature placement (cold resistance)	The controller should act normally when being placed for 50Hr (non power-on state) with the ambient temperature of -40℃.	
3-3-4	Thermal stability	The controller should act normally after 20 circulations (1 circulation per hour) with the ambient temperature of -40℃⇔80℃	
3-3-5	Resistance to vibration	2.0G, 11.7~200Hz, 20min/circulation The controller should act normally without damage after separately applying extra 10 vibration circulations at X, Y and Z directions.	
3-3-6	Impact resistance	**[**Impact**]** IEC60068-2-27: 2008 50G, 6msec, half-sine impact wave, 3 times separately at X, Y and Z directions **[**Repeated impact**]** IEC60068-2-27: 2008 25G, 6msec, half-sine impact wave, ±2,500 circulations separately at X, Y and Z directions	

※ The above information is the reliability test contents implemented by the company, and it is different from property guarantee value.

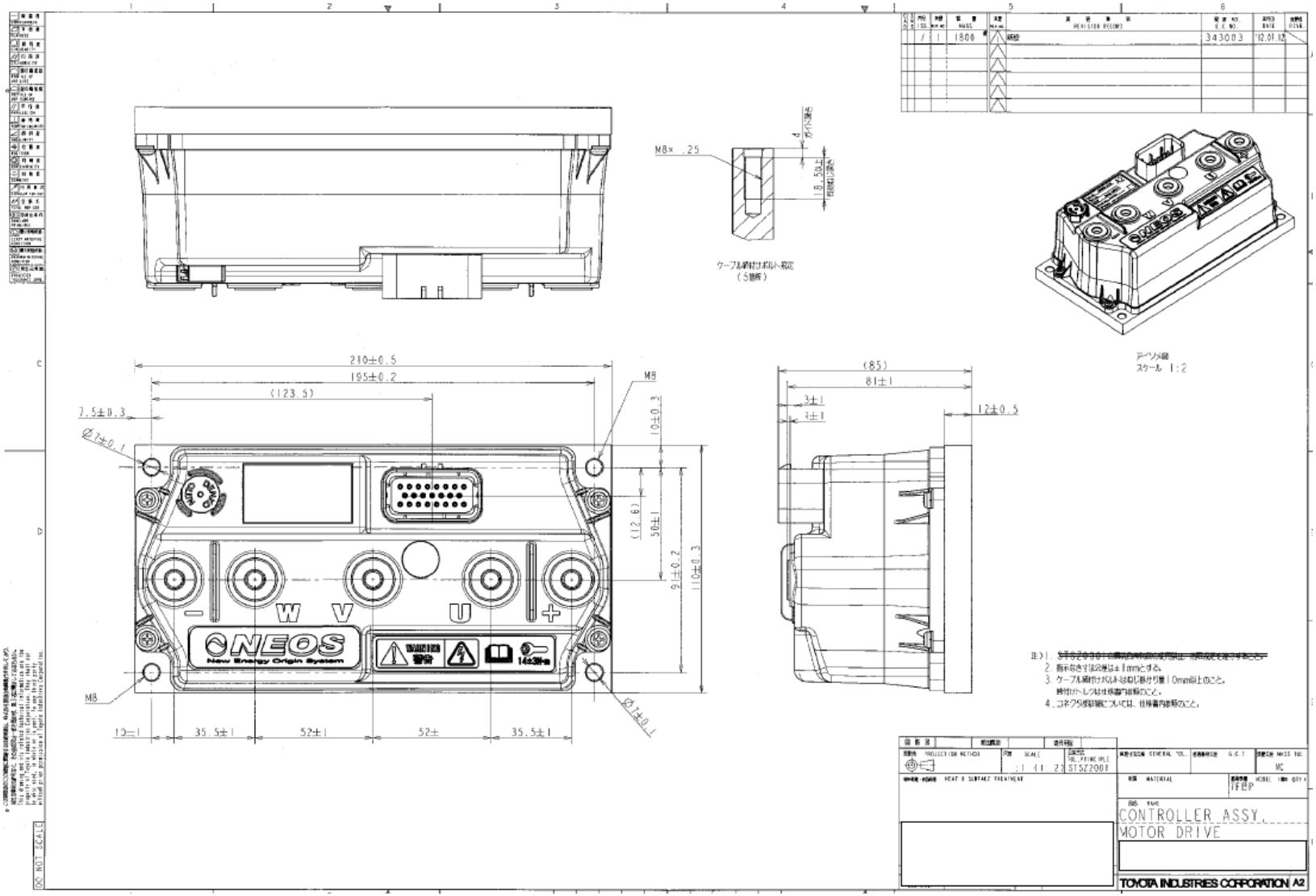
3. Hardware specification

3.4 Protection specification of controller

No.	Item	Specification	Remark
3-4-1	Overload protection control	Stop the output to motor when overloading	
3-4-2	Low voltage protection control	Stop the output to motor when the battery input voltage is smaller than 20V	In addition, in order to protect the battery, it is also allowed to control output by setting parameters. See 5-3 for more information.
3-4-3	Overvoltage protection control	Stop the output to motor when the battery input voltage is greater than 63V	In addition, in order to protect the battery, it is also allowed to control output by setting parameters. See 5-2 for more information.
3-4-4	Board overheating protection control (controller)	• Output current should be limited when the temperature of the main board is above 85℃ and cut off when the temperature is above 88℃. • Output current should be cut off when the temperature of the capacitor board is above 105℃. • Output current should be cut off when the temperature of the controller board is above 105℃. Output current  Temperature of Main PCB Substrate	• It is not recommended to operate when the temperature of the main board is above 85℃. • That may affect the reliability of spare parts.
3-4-5	Short circuit protection control	• Detect phase fault immediately after starting up • Stop the output to motor if short circuit is found	
3-4-6	Low temperature protection control	• Output current should be limited when the temperature of the capacitor board is below -20℃.  Capacitor Board Temperature [℃]	

3. **Hardware specifications**

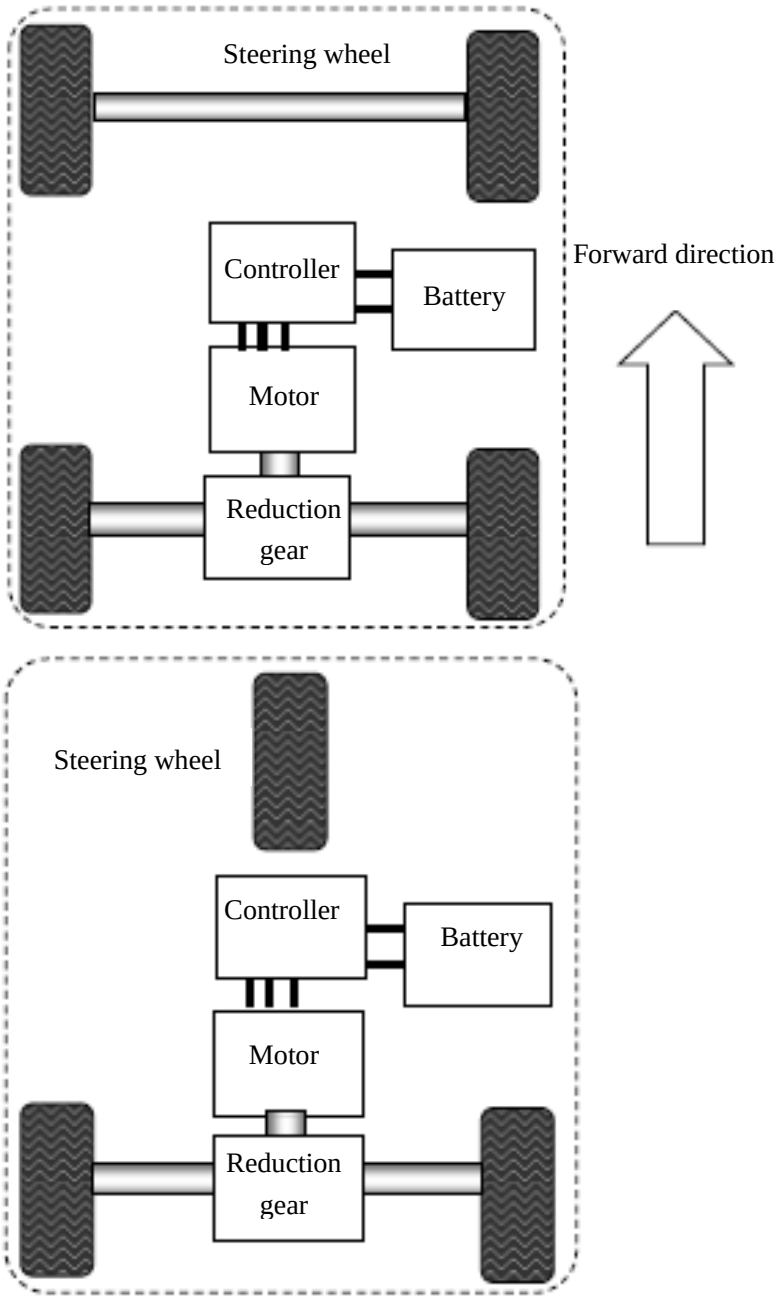
3.5 Outline drawing



4. Driving control specifications

The proposed driving control specifications of the controller are shown as P.7 wiring diagram and the specifications shown in the vehicle formation diagram below. Other vehicle formation specifications should be considered separately.

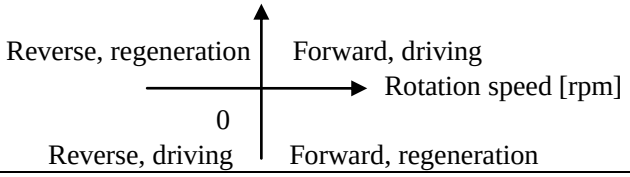
This Specification specifies parameter setting requirements.
Please see [vehicle matching tools v1.5 manual] for more information.



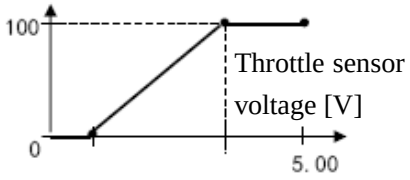
※ There is no proposed specification for applying traction to the steering wheel side.
※There are no proposed specifications for 4WD, wheel hub motor, other motors, speed change mechanism, etc.

4. Driving control specifications

4.1 Generalization, KETSTART, gears and throttle operations

<table>
<tr><th>No.</th><th>Item</th><th>Specification</th><th>Remark</th></tr>
<tr><td>4-1-1</td><td>Driving control mode</td><td>The below two driving control modes are available:
○ Torque control mode
○ Speed control mode</td><td>Select with vehicle matching tool Ver.1.5</td></tr>
<tr><td>4-1-2</td><td>Control quadrants</td><td>Four quadrants Torque [Nm]
 
</td><td></td></tr>
<tr><td>4-1-3</td><td>Rotation direction of motor</td><td>The gear positions which are corresponding to forward and reverse of motor could be set at will.</td><td>Select with vehicle matching tool Ver.1.5</td></tr>
<tr><td>4-1-4</td><td>Output limit</td><td>It is available to conduct certain output limit to one quadrant among the control quadrants (four quadrants)</td><td>It is available to set separately with vehicle matching tool Ver.1.5.</td></tr>
<tr><td>4-1-5</td><td>Judgment of gear position</td><td>Judge gear positions according to the table below to input gear switch (forward switch and reverse switch). However, to switch on reverse switch in forward state or to switch on forward switch in reverse state, you should decelerate to almost 0rpm (zigzag driving position) first and switch gear positions then.
<table><tr><td colspan="2" rowspan="2"></td><td colspan="2">Forward switch</td></tr><tr><td>OFF</td><td>ON</td></tr><tr><td rowspan="2">Reverse switch</td><td>OFF</td><td>Neutral</td><td>Forward</td></tr><tr><td>ON</td><td>Reverse</td><td>Abnormity</td></tr></table></td><td>• When the rotation speed of motor is lower than [-50rpm], the operation of switching to forward gear is invalid.

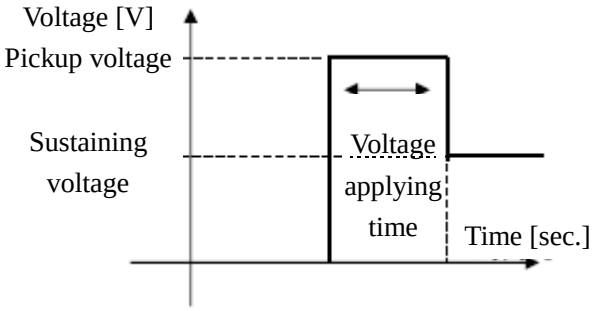
• When the rotation speed of motor is higher than [+50rpm], the operation of switching to reverse gear is invalid.</td></tr>
<tr><td>4-1-6</td><td>Calculation of throttle opening size</td><td>Throttle opening size should be calculated according to the relationship between throttle sensor voltage-throttle opening size when the throttle valve is on.

Throttle opening size [%]
 
</td><td>The relationship between throttle sensor voltage and throttle opening size could be set with vehicle matching tool v1.5.</td></tr>
<tr><td>4-1-7</td><td>HPD control</td><td>The gear position will not change when changing gear position with the throttle being on (throttle opening size ＞5%).

However, when changing gear position to forward and reverse with the throttle being on (throttle opening size ＞5%) in driving, the gear position will be not changed to reverse gear after decelerating to 0 (zigzag driving control) and the vehicle will stop.</td><td>HPD control could be turned on or off with vehicle matching tool v1.5.</td></tr>
<tr><td>4-1-8</td><td>SRO control</td><td>The following limitations could be set for the switch of gear position with KEYSTART being on.
0: Without SRO
1: Back to neutral position
Gear position could be changed if the gear has been at neutral position for more than 100msec.</td><td>The specification of SRO control could be changed with vehicle matching tool v1.5.</td></tr>
</table>

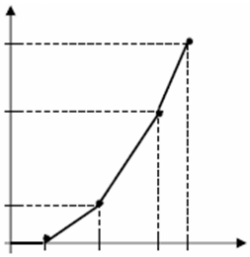
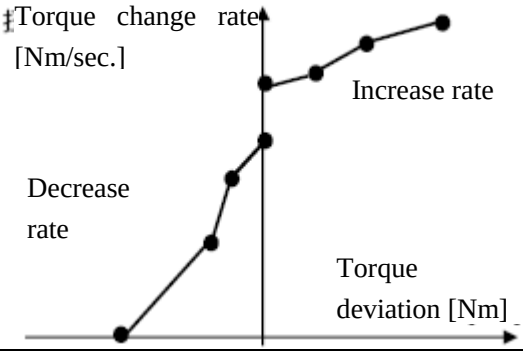
		2: Back to throttle OFF Gear position could be changed if the throttle opening size is ≦5% and has lasted for more than 100msec. 3: Back to Gear position could be changed if and throttle OFF Gear position could be changed if the above two conditions are met simultaneously.	
4-1-9	Emergency reverse control	When switch OFF and ON the throttle successively in zigzag driving state, the gear position will be changed from zigzag driving to reverse gear suddenly. To move gear position urgently, you may set a greater speed control gain until the rotation speed reverses.	Emergency reverse control could be turned on or off with vehicle matching tool v1.5.
4-1-10	Interlock of charger linked switch	The motor is not allowed to output when the charger linked switch is ON.	The (ON_OFF) control of charger linked switch could be controlled with vehicle matching tool v1.5.
4-1-11	Field current stop	Field current output will be OFF if no torque command is given for more than 1sec.	

4.2 Contactor actions

No.	Item	Specification	Remark
4-2-1	Contactor ON control	When conducting KEYSTART ON operation, apply voltage to the contactor to connect.  	The time for pickup voltage, sustaining voltage and voltage applying could be set with vehicle matching toll v1.5.
4-2-2	Contactor OFF control	When conducting KEYSTART OFF operation, make the voltage applied to the contactor OFF.	

4. Driving control specifications

4.3 Torque control mode ※The items recorded on this page are only valid when selecting torque control mode.

No.	Item	Specification	Remark
4-3-1	Throttle valve ON Driving torque	Give driving torque command according to throttle opening size – torque relationship when the gear is at forward position or reverse position with the throttle valve being ON. Torque proportion [%]※1  Throttle opening size [%]	Give driving torque command according to the left when the gear is at forward or reverse position. Throttle opening size and torque could be set with vehicle matching tool v1.5.
4-3-2	Torque Increase rate Decrease rate	Torque deviation ※2: adjust the torque change rate as per the deviation between command torque and actual torque according to the relationship of torque change rate. 	Torque deviation and torque change rate could be set with vehicle matching tool v1.5.
4-3-3	Low speed mode when torque controlling	Driving torque will be limited when the low speed switch is ON and the rotation speed of motor exceeds the preset rotation speed.	Rotation speed limit could be set with vehicle matching tool v1.5.
4-3-4	Maximum speed limit	Driving torque will be limited when the rotation speed of motor exceeds the preset rotation speed.	Rotation speed limit could be set with vehicle matching tool v1.5.

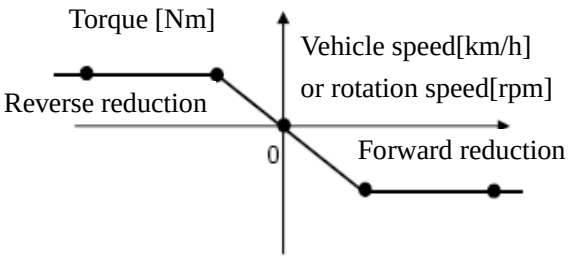
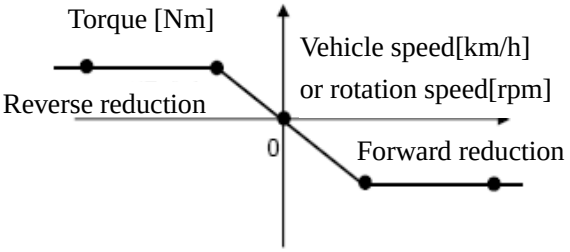
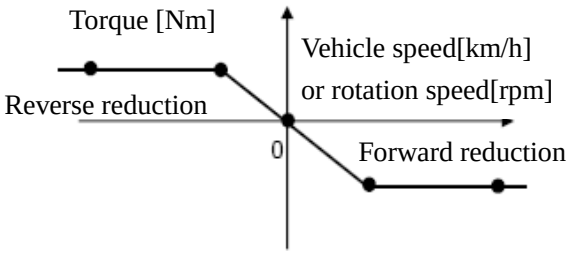
※1 Torque proportion: the proportion of maximum torque corresponding to the present rotation speed

※2 Torque deviation: the deviation value between present torque and command torque

4. Driving control specifications

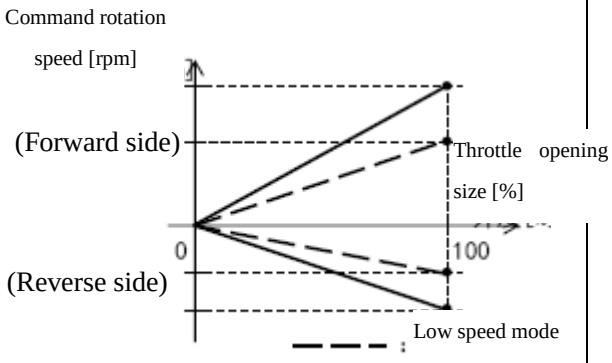
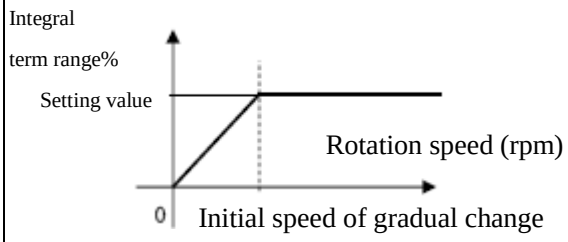
4.3 Torque control mode

※ The items recorded on this page are only valid when selecting torque control mode.

No.	Item	Specification	Remark
4-3-5	Brake override	Make throttle valve ON valid by opening brake switch	
4-3-6	Brake switch ON Reduction torque	Give deduction torque command when the brake switch is ON according to the preset vehicle speed-torque relationship. 	Vehicle speed or rotation speed and torque could be set with vehicle matching tool v1.5.
4-3-7	Zigzag driving deduction torque	Give deduction torque command when zigzag driving according to the preset vehicle speed (or rotation speed)-torque relationship. 	Vehicle speed or rotation speed and torque could be set with vehicle matching tool v1.5. To switch ON reverse switch in forward state or to switch ON forward switch in reverse state, you should decelerate to almost 0rpm (zigzag driving position) first and switch gear positions then.
4-3-8	Throttle valve OFF Reduction torque	Give reduction torque command when the throttle valve is OFF and the gear is at forward or reverse position according to the preset vehicle speed (or rotation speed)-torque relation. 	Vehicle speed or rotation speed and torque could be set with vehicle matching tool v1.5.
4-3-9	Reduction torque calculation	Output the sum of the above three deduction torque values	

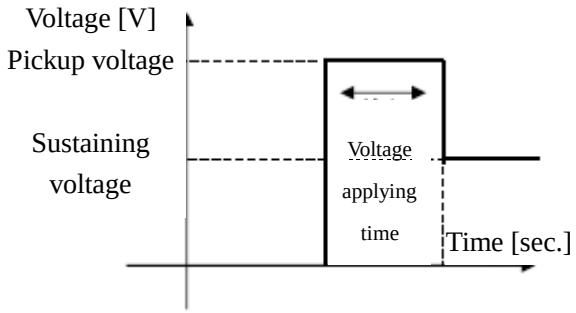
4. Driving control specifications

4.4 Speed control mode ※ The items recorded on this page are only valid when selecting speed control mode.

No.	Item	Specification	Remark
4-4-1	Speed command	Give vehicle speed (or rotation speed) command when the throttle valve is ON according to throttle opening size-vehicle speed (or rotation speed) relationship. In addition, give vehicle speed (or rotation speed) command when low speed switch is ON according to the relationship set as low speed mode. 	Command rotation speed could be set with vehicle matching tool v1.5.
4-4-2	Brake override	When the brake switch is ON, brake and stop the vehicle by making throttle speed command invalid	
4-4-3	Gradient control	Restrain backward sliding when conducting uphill start (It is recommended to set electromagnetic brake)	
4-4-4	Speed Increase rate Decrease rate	Set acceleration limit for actual radial velocity command convergence. Separately set the acceleration to forward gear and reverse gear, and the rotation command will not change faster than the preset limit. In addition, decrease rate could also be set for other circumstances which cause vehicle stop excluding brake switch being ON.	Increase rate and decrease rate could be set with vehicle matching tool v1.5.
4-4-5	RDC control	Adjust vehicle backward sliding actions on gradient through following setting items (when there is no electromagnetic brake setting). • Set integral term range • Set initial speed of the gradual change of integral term range 	The setting value and initial speed of gradual change of integral term could be set with vehicle matching tool v1.5.
4-4-6	Slow stop control	It makes the vehicle stop slowly with the throttle valve being OFF.	The on-off control of the slow stop control could be set with vehicle matching tool v1.5. It should be noted that, if this slow stop control is activated when the throttle valve is OFF, regenerative brake may elongate the braking length.

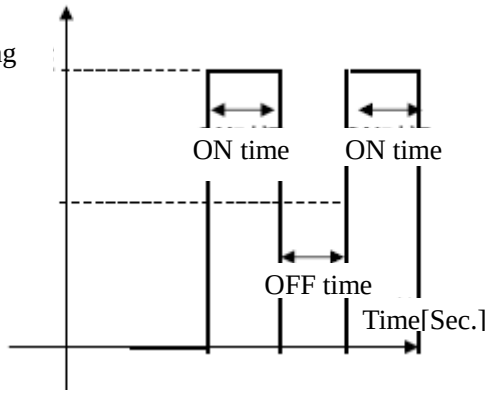
4. Driving control specifications

4.5 Electromagnetic brake actions

No.	Item	Specification	Remark
4-4-1	Use or not use electromagnetic brake	It is available to set electromagnetic brake used to lock the vehicle when stopping output. Alarm apparatus and electromagnetic brake could only be used alternatively. The electromagnetic brake should be of N.C. specification which is used to unlock the brake after applying voltage.	The using of electromagnetic brake could be set with vehicle matching tool v1.5.
4-4-2	Unlocking condition of electromagnetic brake	Electromagnetic brake could be unlocked if the conditions below are all met: • The throttle valve is ON; • The linked switch of charger is OFF; • The driving gear position is at “forward position” or “reverse position”.	
4-4-3	Unlocking control electromagnetic brake	Unlock the electromagnetic brake as per the diagram below after meeting the conditions in 4-4-2.  	Pickup voltage, sustaining voltage and time for voltage applying could be set with vehicle matching tool v1.5.
4-4-4	Conditions for taking effect again of electromagnetic brake	The electromagnetic brake will take effect when any of the following conditions is met. ○The vehicle speed (rotation speed of motor) is below certain rotation speed, any one of the following conditions is met, and the preset standby time has elapsed. • Throttle valve is OFF; • Linked switch of charger is ON; • The driving gear position is not at “forward position” or “reverse position”. ○ The key switch is OFF.	Rotation speed and standby time could be judged with vehicle matching tool v1.5.

4. Driving control specifications

4.6 Alarm apparatus

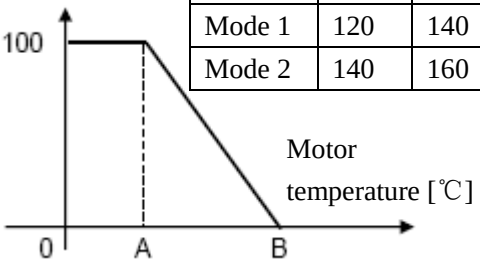
No.	Item	Specification	Remark
4-6-1	Use or not use alarm apparatus	Set alarm apparatus to caution and warn vehicle state. Alarm apparatus and electromagnetic brake could only be used alternatively.	The use of alarm apparatus could be set with vehicle matching tool v1.5.
4-6-2	RDW control	Conduct alarm output as per the designated voltage condition when parking on gradient and it is found that the rotation speed of motor exceeds the preset speed when there is no throttle operation and the duration exceeds the preset time. Unlock the alarm apparatus when it is found that the throttle valve is ON or below critical speed.	The use of RDW control and rotation speed detection and unlocking could be set with vehicle matching tool v1.5. ※ It should be noted that detection could not be done when ECU has no power supply.
4-6-3	Alarm apparatus action control	The alarm will output (ON_OFF circulation action) as per the below diagram after meeting the alarm output conditions specified in 4-6-2. Voltage [V]  	Applying voltage and ON time and OFF time could be set with vehicle matching tool v1.5.

5. Protection control specifications

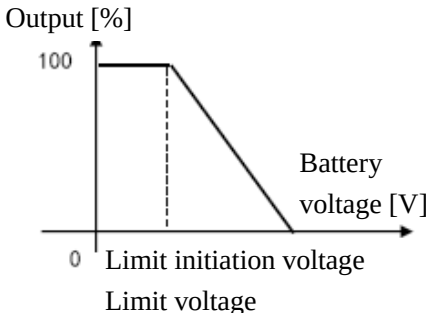
Protection control specifications of motor and battery

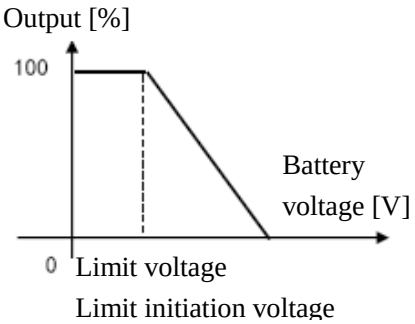
The parameter setting values recorded on this page may cause damage or burn-out of motor or battery. Please set carefully according to the specifications of motor and battery.

<table>
<tr><th>No.</th><th>Item</th><th>Specification</th><th>Remark</th></tr>
<tr><td>5-1</td><td>Output limit/recovery to motor temperature</td><td>Limit output as per the diagram below with the temperature rise of motor and recover as per the diagram below with the temperature drop of motor.

Output [%]
<table><tr><td></td><td>A</td><td>B</td></tr><tr><td>Mode 1</td><td>120</td><td>140</td></tr><tr><td>Mode 2</td><td>140</td><td>160</td></tr></table> 
</td><td>The output is limited by any proportion when motor sensor is not connected.

The protective motor temperature could be set with vehicle matching tool v1.5 from the two modes.

The output limit when motor sensor is not connected could be set with vehicle matching tool v1.5 at will. However, it should be noted that the action when motor sensor is not connected may cause motor overheating danger.</td></tr>
<tr><td>5-2</td><td>Regeneration torque limit to battery voltage</td><td>Limit regeneration torque (deceleration torque) output when battery voltage is above the preset value.
 
</td><td>If gear position and the rotation speed at the opposite direction (backward sliding on gradient) are detected, you should give priority to vehicle action to make the control invalid.

Limit initial voltage and limit voltage could be set with vehicle matching tool v1.5.</td></tr>
<tr><td>5-3</td><td>Driving torque limit to battery voltage</td><td>Limit driving torque (acceleration torque) output when the battery voltage is below the preset value.
 
</td><td>Limit initial voltage and limit voltage could be set with vehicle matching tool v1.5.</td></tr>
</table>

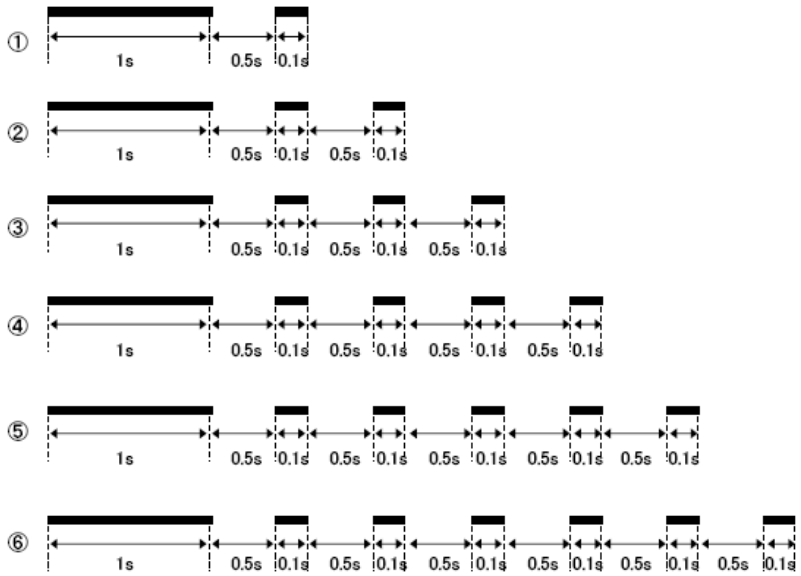
Protection control specifications

Troubleshooting List				
No.	Abnormal Item	Abnormal Condition	Recovery Condition	LED Flicker Mode
5-4	Temperature abnormity	Internal temperature※1 is above 80℃	Internal temperature※1 is below 75℃	① ▬ ▬
		Internal temperature※1 is below -20℃	Internal temperature※1 is below -15℃	
5-5	External wiring abnormity	Contactor coil short circuit	KEY OFF→ON	② ▬ ▬ ▬
		Forward and reverse switches are all ON simultaneously	KEY OFF→ON	
5-6	Current abnormity	|Phase current value| ＞ 630A（48M350） |Phase current value| ＞ 780A（48M450）	KEY OFF→ON	③ ▬ ▬ ▬ ▬
		AD average value of current sensor is not within 2048±140 when stopping	KEY OFF→ON	
5-7	Internal sensor abnormity	Internal temperature sensor short circuit or open circuit	The value of Internal temperature sensor is normal	④ ▬ ▬ ▬ ▬ ▬
5-8	Voltage abnormity	Battery voltage is above 63V	Battery voltage is below 55V	⑤ ▬ ▬ ▬ ▬ ▬ ▬
		Battery voltage is below output limit setting value※2	Battery voltage is above output limit setting value※2	
5-9	Other vehicle abnormities	Vehicle abnormities	Vehicle abnormities removal	⑥ ▬ ▬ ▬ ▬ ▬ ▬

※1: Internal temperature = main board temperature, capacitor board temperature and sensor board temperature

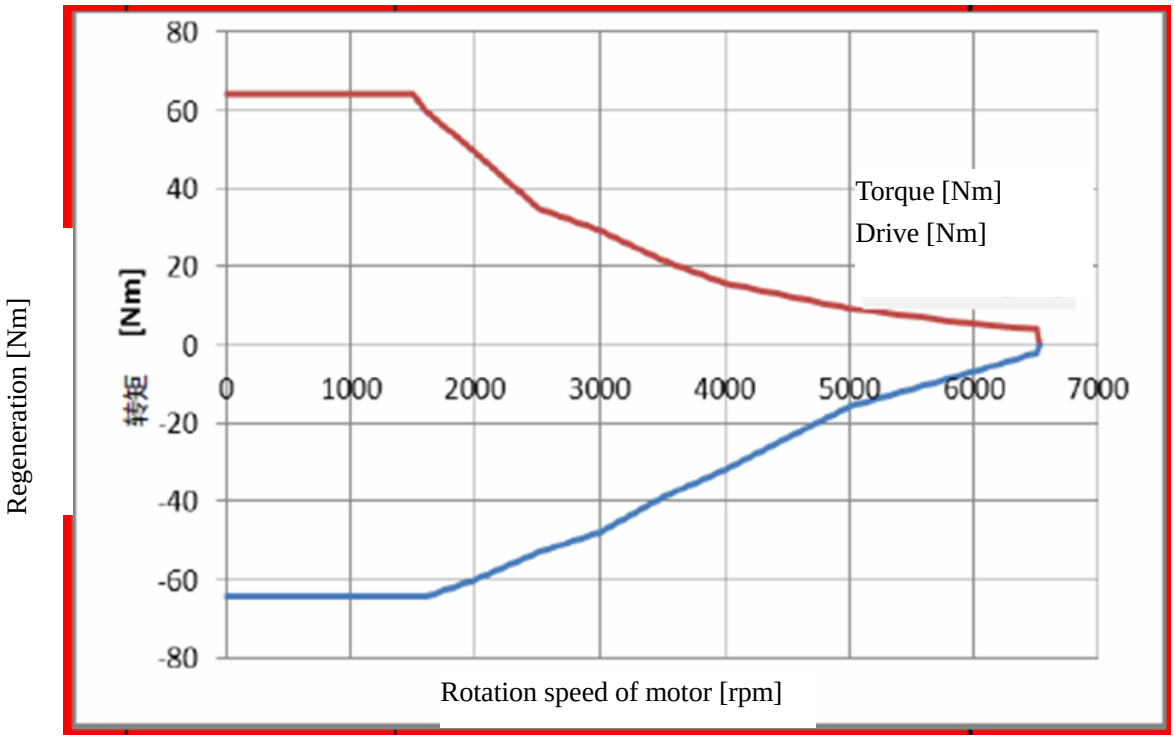
※2: Parameter setting value (refer to 5-3)

Details of LED flicker mode



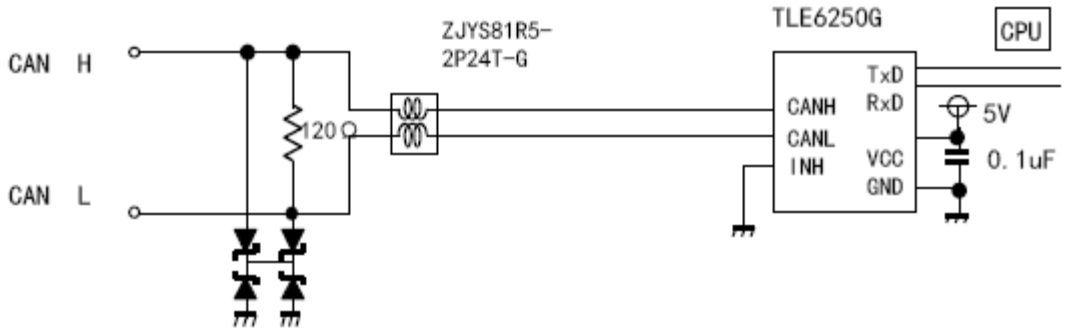
6. Motor control specifications

No.	Item	Specification	Remark
6-1	Applicable motor	HSLT AQHT4-4101B	In this software, map value refers to the fixed value matching with each motor, so it cannot be adjusted. Please do not use for other motors.
6-2	Modulation mode	PWM (pulse amplitude modulation mode)	
6-3	Carrier frequency	8kHz	
6-4	Motor control diagram (internal values)		



7. Reference information (CAN specification: use when matching with control program)

No.	Item	Specification	Remark
7-1	CAN protocol	TICO original CAN	This protocol is used for the purpose of communicating with the tools of the company. Other negotiation should be done separately if the client needs the CAN communication to motor controller.
7-2	CAN interface	ISO 11898	
7-3	Recommended CAN circuit		
7-4	CAN terminal resistance	Built-in terminal at one side	120Ω



8. General precautions related to this Specification

1. The contents recorded in this Specification may be changed due to product or technical improvement without prior notice in future.
2. It is prohibited to reprint partial or all contents of this Specification without authorization.