

KCCA0391 Controller Operator's Manual

**Includes Scrubber/Sweeper Controller
Functional Safety Description for 24 and 36 VDC**

For technical assistance or questions
related to the 150A Scrubber/Sweeper Controller, call
Customer Service: 1-330-734-3600

Read the entire manual prior to using the Controller.
Follow all instructions contained herein.

The Nidec logo is rendered in a bold, italicized, green sans-serif font.

NIDEC MOTOR CORPORATION



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Version Log

Revision Number	Date	Author	Change Description
A	27/02/2020	Ajay Dandge, Daniel Morton	New Draft
A.1	10/18/2020	Ajay Dandge	<ol style="list-style-type: none"> 1. Connector Details are updated in "Connector and Terminal" 2. Wiring diagram is updated. 3. "FS" notation is added to relevant parameters in section "Controller Parameter". 4. Brake status is updated in SF01 description. 5. Section "Fault Diagnostic System" is updated with a note for NDS Host usage. 6. Section "Fault Code Table" is updated with a note regarding Sensor diagnostic.
A.2	11/4/2020	Ajay Dandge	<ol style="list-style-type: none"> 1. CAN Communication protocol section is updated to show CAN CRC bytes. 2. "Accelerator low limit" added in parameters list.
A.3	11/19/2020	Ajay Dandge	<ol style="list-style-type: none"> 1. Added parameter number 196. 2. Modified description for parameter 23. 3. Added subsection "Safe State Response Time" in section "Information Relevant to Functional Safety". 4. Added note in "Characteristics of the Safety Functions" section for PFH calculations. 5. Updated description in "Controller Parameters" section for FS parameter configuration process.
A.4	12/4/2020	Ajay Dandge	<ol style="list-style-type: none"> 1. Added note in "Characteristics of the Safety Functions" section for relay operations (max number).
A.5	12/9/2020	Ajay Dandge, Imtiyaz Memon	<ol style="list-style-type: none"> 1. Updated safety related information as per table 1 of UL60730.
A.6	12/17/2020	Ajay Dandge	<ol style="list-style-type: none"> 1. Added programmable parameter #198. 2. Updated safety function classification to Class B as per IEC 60730. 3. Added note in section "Safe State – Deck Function" about recommended use of programmable parameter.
A.7	12/01/2021	Ajay Dandge	<ol style="list-style-type: none"> 1. Updated fault code list in section "Fault code table". 2. Added "Controller Parameters configuration Matrix" section.
A.8	2/1/2021	Ajay Dandge	<ol style="list-style-type: none"> 1. Added explanation for configuration F10. 2. Modified description for fault code 15 and D2 in "Fault Code Table".
A.9	2/3/2021	Ajay Dandge	<ol style="list-style-type: none"> 1. Added more configuration in "Controller Parameter Configuration Matrix".
A.10	2/10/2021	Ajay Dandge	<ol style="list-style-type: none"> 1. Added parameter sr. no. in "Controller Parameter Configuration Matrix". 2. Added Notes below table "Controller Parameter Configuration Matrix" for other parameters.
A.11	2/15/2021	Daniel Morton	<ol style="list-style-type: none"> 1. Reduce the Table of Contents to a single page. 2. Rearranged the customer-approved content.

Important Safety Information

This Operator's Manual contains important safety, operating, and installation instructions for the 150A Scrubber/ Sweeper Controller-PM Motor. Save the manual and read it before operating or using the controller. Read and understand all safety precautions before operation or performing maintenance. Improper practices or carelessness can cause burns, cuts, other bodily injury, or death.

WARNING

- Read and understand these manufacturer's instructions and your employer's safety practices.
- Electric vehicles can be dangerous. All testing, fault-finding, and adjustment should be carried out by qualified personnel. Consult the vehicle manufacturer's manual before attempting any operation.
- Always disconnect the battery terminals before making changes to the wiring on the controller. After the battery has been disconnected, wait 30 seconds for the internal capacitors to discharge residual electricity before handling the controller.

CAUTION

- When working with motor controller equipment, even though great care has been taken to prevent accidental vehicle operation, there is still the possibility of electric shock or unintended operation. Disconnect the batteries from the vehicle before any work is to be performed.
- Batteries will give off hydrogen gas in the charging and discharging process. Follow all of the battery manufacture's safety precautions.
- High currents can be generated through the batteries and the controllers. Follow all electric safety precautions and safety equipment.
- Programmable option changes can cause unpredictable vehicle operation, resulting in possible injury or fatality.
- **DO NOT** open the controller. There are **NO** serviceable parts in the controller.

About the KCCA0391 Scrubber/Sweeper Controller

The Nidec Drive Systems (NDS) Controller provides control of all functions of ride-on or push behind scrubber in a single unit – the perfect solution for commercial floor care machines. Available for 24 and 36 VDC systems, the fully programmable scrubber controller provides variable speed control, regenerative braking for the traction motor, and programmable current limits for all the motors.

The controller has complete protection functions, such as over/under current, short-circuit, and over/under voltage protection. It also provides self-testing and continuous diagnostics, including error code history. The controller provides 14 digital inputs and 4 programmable auxiliary outputs. The controller uses CAN communication which reduces the cost and complexity of bulky harnesses running between the operator console and the controller.

Our design team can provide a customized control panel design to meet your specific application. Hour meters, battery discharge indication, error code, and diagnostics are shown on the LCD display, eliminating the need for auxiliary gauges. Individual LEDs and membrane switches can complete the vehicle integration.



General Specifications

The KCCA0391 Controller includes a 32-bit microcontroller for motor control and main functions, 256 Kbytes embedded Flash memory for the primary and 128 Kbytes for the secondary microcontroller.

- Redundant microcontroller for improved safety
- 32 bit CRC engine used for EEPROM, Flash, UART, and CAN
- Driver for the Line Contactor coil
- Driver for the pre-charge circuit
- Diagnostics provided via CAN bus using NDS Host tool for PC
- User-Programmable via NDS Host
- Self-test and continuous diagnostics, including error code history
- Complete protection from dust, oil, and other non-corrosive material meets IP Grade, such as IP54

Technical Specifications

- 24 / 36 VDC
 - Traction Current Limit: 150A, Continuous: ~ 70 A
 - Brush Current Limit: 120A, Continuous: ~ 60A
 - Vacuum Current Limit: 50A, Continuous: ~ 30A
 - Squeegee & Brush Deck Actuators
 - Bidirectional
 - Current Limit: 7A, Continuous: 4A
 - Brake, Beeper, Valve Current Limit: 10A, Continuous: ~ 4A
 - Aux 1, Aux 2 Output Current Limit: 5A, Continuous: ~ 2A
 - Working Temperature (Ambient): -20° C to 55° C, (-4° F to 131° F)
 - Shut Down Temperature: 75° C, (167° F)
 - Limited: 70° C, (158° F)
 - Back: 65° C, (149° F)
 - Storage Temperature: -40° C to 85° C, (-40° F to 185° F)
 - Variable speed control
 - 14 digital inputs
 - 4 programmable auxiliary outputs
 - 1 Status PWM output
 - Over current protection for all motors
 - Short-circuit protection for all motors
 - Over and under voltage protection
 - Support for Hall and Resistance type accelerator
 - Regenerative Braking
 - CE, TUV, UL, EMC (certifications pending)
 - Functionally safety complaint with standard IEC61508, UL60335-1, and UL60730-1 (certification pending)
 - SIL level 2 for traction control*
 - SIL level 1 for park brake and deck actuator control*
- * Under safety considerations

Electrical Specifications

Outputs	Current Limit	Operating Voltage	Continuous Current
Traction	150A	24/36 VDC	70A
Brush	120A		60A
Vacuum	50A		30A
Squeegee Actuator	20A		10A
Brush Deck Actuator	20A		10A
Brake	10A		4A
Beeper	10A		4A
Valve	10A		4A
Aux 1 Out	5A		2A
Aux 2 Out	5A		2A

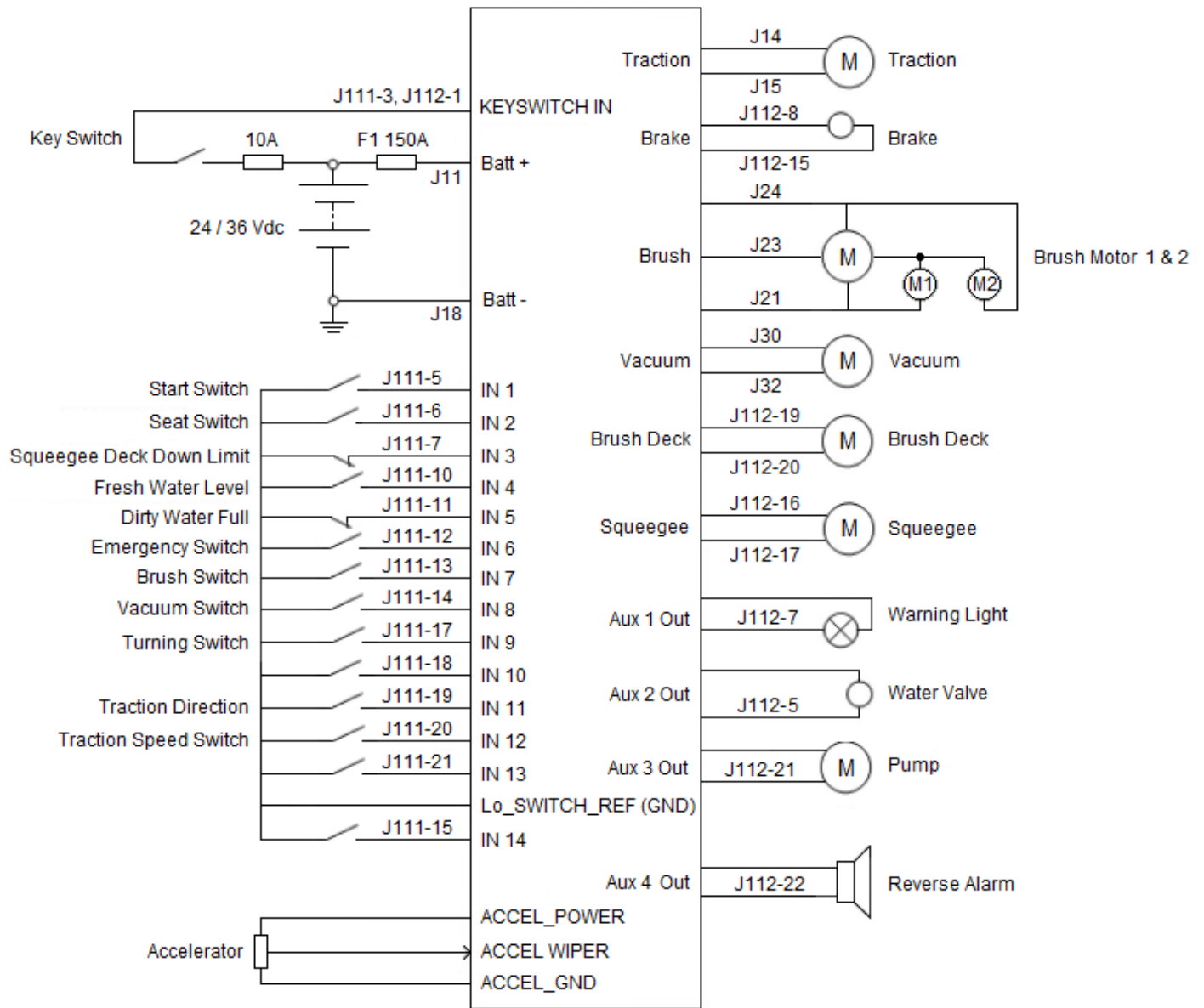
Terminal Definitions

J111 Connector (Input /Output)	
Pin 1	DGND
Pin 2	POT HI
Pin 3	KEYSWITCH_IN
Pin 4	POT LOW
Pin 5	IN 1
Pin 6	IN 2
Pin 7	IN 3
Pin 8	+5V @1A
Pin 9	POT_Wiper
Pin 10	IN 4
Pin 11	IN 5
Pin 12	IN 6
Pin 13	IN 7
Pin 14	IN 8
Pin 15	+12V @1A
Pin 16	IN 14
Pin 17	IN 9
Pin 18	IN 10
Pin 19	IN 11
Pin 20	IN 12
Pin 21	IN 13
Pin 22	Not connected
Pin 23	DGND

J112 Connector (Input /Output)	
Pin 1	KEYSWITCH_IN
Pin 2	Not connected
Pin 3	AUX SUPPLY1
Pin 4	AUX SUPPLY2
Pin 5	AUX 2 OUT
Pin 6	LINE COIL SUPPLY
Pin 7	AUX 1 OUT
Pin 8	BRAKE+
Pin 9	CAN_H
Pin 10	CAN_L
Pin 11	Not connected
Pin 12	STATUS_PWM
Pin 13	Not connected
Pin 14	LINE COIL OUT
Pin 15	BRAKE-
Pin 16	SQUEE OUT A
Pin 17	SQUEE OUT B
Pin 18	Not connected
Pin 19	BRUSH DECK OUT B
Pin 20	BRUSH DECK OUT A
Pin 21	AUX_3 OUT
Pin 22	AUX_4 OUT
Pin 23	DGND

Wiring Connections

The KCCA0391 Controller uses internal relays for connecting the battery to the power circuits. The programmable functionality and parameters however are the same for both.



Note: IN1, IN2, IN11-IN14 are used for driver-present switch inputs. IN13 is reserved for analog input.

Installing the Controller

Procedures and Requirements

- Provide an installation schedule well ahead of time.
- The installation should be performed by skilled/trained technicians who has thorough knowledge of the system's working principles and the functions.
- Attach the controller to a clean, flat metal plate. Use an aluminum plate greater than or equal to 5mm thickness.
- Evenly spread a thin layer of thermally conductive silica gel between the bottom of the controller and the metal plate, if necessary.
- The controller should be installed in an area to maximize both ventilation and heat dissipation.
- The controller can be mounted vertically or horizontally in an area that is both clean and dry. If that is not available, a cover should be added to protect the controller from water and other contaminants.
- Refer to **page 5** for outline and mounting hole dimensions.
- Adequate protection against accidental contact with live parts satisfies standard IEC60335-1 clause 8.1.
- Refer to the wiring diagram and connector tables for connection loads.

Precautions and Electrical Requirements

Note: All switches must be in the disconnected position. Live operation is strictly prohibited.

- The main fuse and control circuit fuse must be installed to match the maximum current value.
- The connection between the motor, battery, and controller should be as close as possible and kept parallel.
- Keep small current cables away from large current cables. Cross them in an orthogonal direction.
- Twist the CAN communication bus in pairs and cover with a shield.
- All cross-sectional areas of connection must meet current requirements.

Installation Sequence

The parts needed for installation of the controller are:

- Scrubber controller unit
- Fitting bolts

Mounting Characteristics

Controller Mounting Holes

- Hole Size: 2 x 0.20 in (5 mm)
- Clearance Area: 0.65 in (16.5 mm)

Hex Head Brass Bolts

- Type: M6 x 12
- Size: 0.39 in (9.8 mm) x 0.64 in (16.2 mm)
- Material: H59
- Strength Grade: 4.8
- Reference Standard: DIN933
- Torque Limits: 4 – 4.5 Nm

Terminals

- Clearance Area: 0.68 in (17.2 mm)
- Ring Terminal size: Must be able to accommodate an M6 bolt.
- Appliances shall be provided with terminals, or equally effective devices for the connection of external conductors which satisfies the following safety standards:
 - UL60335-1 clause 26.1 and 26.11
 - UL60730-1 clause 7.4.2

Criteria for Declaring Installation Activities as Complete

- Document all installation activities.
- Carry out all controller functional testing and verify that all functions are operational.
- Conduct all safety-related functional testing outlined in Proof Tests on **page 17**.

Operations, Safety Features, and Recommendations

KCCA0391 is IEC61508, UL 60335, and UL 60730 certified functionally safe design (certification pending). This section provides information about the safety design features of the control unit and necessary recommendations for safe operation of the control unit and relevant scrubber/sweeper machine system.

Safety Features

This design employs redundant circuits, including micro-controllers to process safety-related inputs and outputs such as accelerator, traction control, park brake control and brush deck control.

Protection against electrical failures such as electrical short circuit, open circuit and disturbances due to electrical transients are provided. In the event of such electrical failures, fault code will be logged, shown on the dashboard (if equipped), the main relay (onboard contactor) will open, traction output will be stopped in controlled manner, and brakes will be engaged.

Faults not related to the traction circuit will not lead to opening the contactor. However, traction output will be lowered so that user can drive the machine to repair location for diagnosis and repair of the fault.

Note: For additional information on the Fault Diagnostic System refer to **page 69**.

Recommended Machine configuration

The machine shall have some form of park or E-brake system.

It is recommended to have an electrical sensor for the seat (operator presence) so that controller can detect whether a person is controlling the machine.

Keep power cables lengths as short as possible to minimize power losses.

Do not connect the controller to a power source with a voltage larger than <60 V. A greater voltage may cause a power section failure.

Abnormal operating conditions, like very hot ambient temperatures, should be considered.

The enclosure provides the degree of moisture and humid protection according to classification of the appliance which is implemented to satisfy standard UL60335-1 clause 15.1, 15.2 and 15.3.

The risk of fire, mechanical damage, or electric shock under abnormal or careless operation satisfies UL60335-1 clause 19.1 and UL60730-1 clause 12.

Moving parts must be adequately arranged or enclosed so as to provide protection against personal injury per UL60335-1 clause 20.1 and 20.2.

Before Starting the Machine

All switch inputs and accelerator inputs must be in Neutral/OFF state. If the accelerator is held at any other position than the zero position, the controller will not command traction until the accelerator input is zero. Then, traction is commanded again so as to ensure that an accelerator stuck condition does not persist.

At key cycle, the controller performs a self-check which includes confirmation of input battery voltage range, absence of fault conditions, and over temperature, etc. In the event of any fault condition, the controller logs the fault code and disable/lower the traction. Temperatures are monitored continuously and are not allowed to exceed the predefined values specified in UL60335-1 clause 11.8, and UL60730-1 clause 6.12.

The parking brake must be engaged, and the key switch must be turned off before leaving the scrubber unattended.

Battery polarity inversion: For safety reasons, it is necessary to fit a main contactor in order to protect the inverter against reverse battery polarity.

Protection against external agents like dust and liquid must be provided satisfies UL60730 clause 21.

As a protection against an uncontrolled switch-on, the main contactor will not close if the power section is not working properly.

During Machine Operation

Operating the scrubber in a fault condition while on an inclined surface may result in unintended motion.

In the event of specific faults, the speed of the machine is lowered, typically to less than half of maximum possible speed.

In the event of fault code detection, continued use of machine is not recommended apart from driving the machine to a safe parking location.

Note: The maximum expected voltage drop for the battery cable depends on the length of cable. For example, if the cable used is 1meter length, then the voltage drop is ~0.1V.

Controller Customization

Inputs to the Scrubber Controller

The scrubber controller has the capability of accepting inputs. The scrubber controller's software, along with an external provided program called NDS Host (or the smart display, if used), allows the selection of various pre-defined types of inputting devices (e.g., switches, potentiometers (pots)) connected to the scrubber controller to the customization of product variations and user experiences.

The scrubber controller can accept the following inputs.

#	Description	Qty	Typical Inputs	# of Types of Inputting Device	Software Configurable (for types)
1	Dedicated input for key switch	1	For key switch	SPST switch	No
2	Dedicated input for accelerator	1	Select one type of accelerator input	<ol style="list-style-type: none"> 1. 2-wire pot – increasing resistance 2. 2-wire pot – decreasing resistance 3. 2-wire Wig Wag pot – increasing resistance 4. 2-wire Wig Wag pot – decreasing resistance 5. 3-wire pot 6. 3-wire WIG WAG pot 7. 0-5V hall switch 8. 0-12V hall switch 9. CAN Messages 10. No inputting device (Requires start switch.) 	Yes, for all types of input devices.
3	Physical inputs (Checked Inputs)	6	Select a maximum of 6 physical inputs out of the following inputs as Checked Inputs: <ol style="list-style-type: none"> 1. Operator presence switch 2. Traction Speed Control switch or CAN message 3. Direction (FR or FNR) or CAN message 4. Others per safety requirement 	Customer can choose from the following: <ol style="list-style-type: none"> 1. SPST 2. SPDT 3. CAN Message for each input <p>Note: CAN message(s), if used in lieu of a physical input, make that input available for different physical inputs in the list.</p>	Yes, for all types of input devices, as well as making any of these 6 inputs as non-redundant.

#	Description	Qty	Typical Inputs	# of Types of Inputting Device	Software Configurable (for types)
3	Physical Inputs (Inputs)	8	<p>There are 8 maximum physical inputs out of following inputs as inputs. Of these 8 inputs, 3 inputs are marked as "Auxiliary" inputs on the scrubber controller.</p> <ol style="list-style-type: none"> 1. Electric park brake disables detect 2. Electronic service brake input 3. Charge Port Switch or CAN message 4. Start switch 5. On-the-fly traction speed control input 6. Traction Motor temperature input 7. Brush deck up/down or CAN message 8. Brush enable input Or CAN Message 9. Brush pressure level input or CAN message 10. Brush load / unload switch or CAN messages 11. Brush Speed control switch or CAN message 12. Vacuum enable or CAN message 13. Vacuum level 14. Squeegee up/down switch or CAN message 15. Dirty water input (e.g. Aux i/p -1) 16. Clean / fresh Water empty input (e.g., Aux i/p -2) 17. Horn Switch (e.g., Aux i/p -3) 	<p>The customer can choose from following types.</p> <ol style="list-style-type: none"> 1. SPST 2. SPDT 3. CAN Message for each input <p>Note: CAN message(s), if used in lieu of a physical input, make that input available for different physical input in the list.</p> <p>The E-Stop switch is also a physical input but not directly to the controller. It is a part of the unit protection.</p>	Yes, for all types of input devices.

#	Description	Qty	Typical Inputs	# of Types of Inputting Device	Software Configurable (for types)
3	Physical Inputs (Inputs) Continued	8	18. Clean / fresh water valve On/Off or CAN message 19. Clean / fresh water pump On/Off or CAN message 20. Soap valve On/Off or CAN message 21. Soap pump On/Off or CAN message 22. Auto Function (excluding traction) switch or CAN message 23. Eco Function (excluding traction) switch or CAN message		

The scrubber controller has 14 physical digital inputs (excluding acceleration and key switch input) and 4 auxiliary outputs which can be configured by OEMs as needed for specific machine configuration. 6 of the 14 inputs are safety critical.

All of the inputs are either connected to +BAT or -BAT. These inputs connect to microcontrollers via a signal conditioning circuit, so that input to the microcontroller does not go beyond the input specification of the microcontroller. Both microcontrollers monitor the checked inputs and acceleration input, and take action accordingly.

Inputs Specifications for the Scrubber Controller

- Number of Inputs: 14
- Checked Inputs: 6
- Input Voltage Range: 16.8V – 46.8V
- ADC Voltage: 3.3V

Information Relevant to Functional Safety

Safety-Related Functions

- Safety-related functions are traction and brush deck.

Traction Function

- This function of the system controls the traction motor actions (forward/reverse and left/right).
- These are based on various inputs, like operator presence, start switch input, direction input, speed selection input, and accelerator inputs.

Deck Function

- The Deck function of scrubber controller includes two different deck functionality:
 - Brush Deck function
 - Squeegee Deck function
- The scrubber controller is suitable for use in a safety-related system pursuant to IEC 61508 up to SIL 2. Refer to the table below for the SIL level of each function.

Function	Failure Mode	Safety Function	SIL Level
Traction	Unintended acceleration	SF01: Prevent unintended acceleration (motion)	02
	Unintended excess acceleration than intended	SF02: Prevent more acceleration (motion) than intended	02
	Unintended excess deceleration than intended	SF03: Prevent low acceleration (motion) than intended	02
	Unintended acceleration in wrong direction	SF04: Prevent wrong direction acceleration (motion)	02
	Park brake failure	SF05: Prevent park brake failure	01
Deck	Deck functionality failure	SF06: Prevent unintended deck down	01

- A FMEDA (Failure Mode Effects and Diagnostic Analysis) has been carried out to assess possible design-related failures and to classify these into Safe and Dangerous failures, and to verify SIL level.

Safe State - Traction Function

- Initial Condition-Stationary: The controller does not activate the traction motor in the case of sensor/output faults
- Running Condition: The controller disables traction, applies the park brake and then shuts down the contactor (as also in the case of any fault in the sensor or output device).

Safe State - Deck Function

- Initial State – Deck Up, Traction ON (or OFF)
 - The controller does not activate Deck Down output.
- Initial State – Deck Down, Traction ON (or OFF)
 - The controller disables further activation of Deck Down output and sets Traction Speed to low (a configurable parameter). To avoid any hazard, the vehicle is set at lowest possible speed when the Deck Down function is called.

Characteristics of the Safety Functions

Since the source demand of all safety functions are in continuous demand, safety functions are also under high or continuous demand. Refer to the table below for characteristics of all safety functions. All information is given as per the FMEDA analysis report.

Note: The characteristic safety values, like PFH, SFF, HFT, and all failure etc., are taken from the FMEDA report. The function of the devices has to be checked within the proof test interval (T1).

Parameters according to IEC 61508:2010	Characteristic values for SF01	Characteristic values for SF02 & SF03	Characteristic values for SF04	Characteristic values for SF05	Characteristic values for SF06
Mode of operation	Continuous mode	Continuous mode	Continuous mode	Continuous mode	Continuous mode
Device Type	B	B	B	B	B
HFT	1	1	1	1	0
SIL achieved	2	2	2	2	2
λ_{Sa} safe detected	48.1639	48.1403	34.7635	48.8036	45.0656
λ_{Su} safe undetected	1.4438	1.4435	1.0032	1.1428	1.0578
λ_{Da} dangerous detected	184.8357	184.8593	185.2717	186.4457	99.1954
λ_{Du} dangerous undetected	3.4005	3.4008	3.536	3.3758	2.3171
SFF	98.57%	98.57%	98.43%	98.59%	98.43%
DC	98.19%	98.19%	98.13%	98.22%	97.72%
MTTR	48 hrs	48 hrs	48 hrs	48 hrs	48 hrs
PFH	2.08E-10	2.10E-10	5.13E-10	2.07E-10	3.01E-09
T1	6 months	6 months	6 months	6 months	6 months
Diagnostic Interval	Logic solver -2 min. & sensor and final element- 2 hours				-

Periodic Proof Tests

According to IEC/EN 61508-2, a recurring proof test must be undertaken to reveal potentially dangerous failures that are not detected otherwise. Check the function of the subsystem at periodic intervals, depending on the PFHavg applied, in accordance with the characteristic safety values.

Note: The proof tests are performed during maintenance of the system while the system is in use at the customer site.

- Run the proof tests in every 6 months' duration.
- The proof tests must be performed by skilled/trained technicians who have thorough knowledge of the system's working principles and the functions.
- It is the responsibility of the technician to supply necessary instruments or tools when performing maintenance and required system tests.

The following constraints should be taken into account before proceeding with the proof tests:

- **DO NOT** connect the controller to a power source with a voltage larger than $\leq 50V$ V. A larger voltage may cause a power section failure.
- The operating current of scrubber controller must not exceed 150A.
- **DO NOT** operate the system on an inclined surface.
- In case of a fault condition, **DO NOT** operate the system unless driving the machine to a safe parking location.

Scrubber controller proof test procedures can be categories by following two test methods:

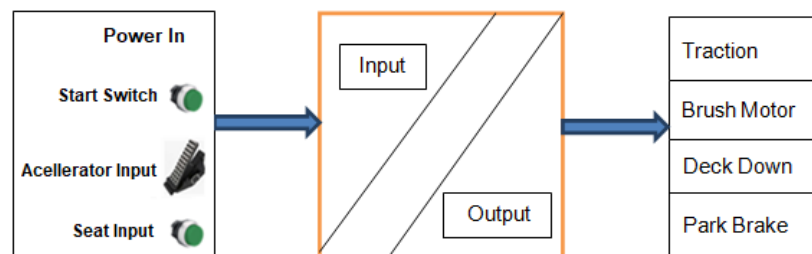
- System - Normal operation test.
- Input /Output functional safety characteristics test.

System Normal Operation Test

- Make sure that the module to be tested is operating normally in the target system, without errors and in Energized mode. If the module is connected in a faulty or de-energized loop, restore normal fault-free and energized conditions before testing.
- Test the input channel by providing rated voltage for the application and check whether the system is getting turned on or not.
- Check that system individual operations are working, e.g., the traction motor, brush/vacuum motor, brush deck, squeegee deck, etc., based on the various input signals.
- Check the traction function for forward and reverse motion, giving the respective traction inputs from the system's control panel.

Input / Output Characteristic Functional Safety Test

The scrubber controller application system with safety functions is represented below.



Perform proof tests below to verify the system safety function status.

Traction Function Based on Start Switch Input Test

1. Turn on the input power supply with rated voltage, as per the application system rating.
2. Turn on the start switch, operator presence switch and gradually press the accelerator paddle.
3. While the traction motor is running switch off the start switch and check the system behavior.

Expected Result: The scrubber controller should detect the absence of start switch input. Traction motor speed should slow down gradually and be stopped.

Traction Function Based on Operator Presence Test

(If installed/configured)

1. Turn on the input power supply with rated voltage, as per the application system rating.
2. Turn on the start switch, operator presence switch, and gradually press the accelerator paddle.
3. While the traction motor is running, switch off the operator presence switch and check the system behavior.

Expected Result: The scrubber controller should detect the absence of operator presence. The traction motor speed should slow down gradually and be stopped.

Vehicle Acceleration Based On Acceleration Pedal Input Test

1. Turn on the input power supply with rated voltage, as per the application system rating.
2. Turn on the start switch, operator presence switch, and fully press the accelerator paddle. Check the system behavior.
3. Then, restart the system. Turn on power supply, the start switch, the operator presence switch and gradually press the accelerator paddle.
4. When the vehicle is at high speed, remove the acceleration paddle and check the system behavior.

Expected Result: Even though the acceleration pedal is pressed fully at the start, the traction motor speed should increase gradually until maximum speed is reached, based on the acceleration paddle press status, rather than experiencing any jerk in vehicle movement. Similarly, when the system is at high speed and then the acceleration input is missing, the traction motor speed should slow down gradually and be stopped.

Traction Function Based On Direction Switch Input Test

1. Turn on the input power supply with rated voltage, as per the application system rating.
2. Turn on the start switch, the operator presence switch, and gradually press the accelerator paddle till the system reach its maximum speed.
3. Run the traction motor in a forward direction.
4. When vehicle is at high speed, change the FNR switch (direction switch) to run the traction in backward direction, and check the system behavior.

Expected Result: When the direction change function is called at high speed, traction motor speed should gradually decrease to Low Speed Mode, then change the direction of the vehicle, and gradually reach to the traction speed based on accelerator input.

Contactor Connection Test

1. Turn on the input power supply with rated voltage, as per the application system rating.
2. Turn on the start switch, THE operator presence switch, and gradually press the accelerator paddle.
3. Press the emergency stop switch and check the system behavior.
4. Then, release the stop switch and repeat Steps 1-3 several times. Check the system behavior.

Expected Result: Each time the emergency stop switch is pressed, the system should apply the brake and stop. After releasing the emergency stop switch and restarting, the system should operate normally. This test checks the brake and relay/contactors status (whether it is stuck, or a welded failure has occurred).

Brush or Squeegee Deck Down Function Test

1. Turn on the input power supply with rated voltage, as per the application system rating.
2. Turn on the start switch, the operator presence switch, and gradually press the accelerator paddle until reaching Full Acceleration Mode.
3. Then, turn on the squeegee deck down function and check the system behavior.

Expected Result: When the squeegee deck down function is called at high speed, the traction motor speed should gradually decrease to Low Speed Mode. Then, the squeegee deck function should run.

Note: If an emergency situation occurs due to a failure in the system, the following action(s) can be taken to reduce or stop a hazardous event:

- Press the emergency stop switch.
- Remove the foot from the accelerator pedal.
- To understand the failure of system, a Fault Diagnostic System is developed which helps to provide accurate diagnosis and troubleshooting of certain problems experienced by the controller. Refer to the Fault Diagnostic System for additional information.

Safety Recommendations

- IN1, IN2, IN11, IN12, IN13 and IN14 are safety critical inputs. It is always better to use safety critical input for speed, direction, start, and operator presence inputs.
- It is always better to have redundant signals for speed, accelerator, and direction inputs for better safety of the system.
- It is recommended to have redundant inputs for acceleration. Use IN13 for the acceleration redundant input, as it is an analog safety critical input.
- In case redundancy for acceleration is not possible, use the start input with acceleration input for safety purposes. As a safety precaution, unless both accelerator and start inputs are ON, the vehicle will not accelerate.
- It is recommended to have an electrical sensor to identify operator presence so that the controller can detect whether a person is controlling the machine.

Maintenance and Repair

1. Check the observation points of the scrubber controller.
2. Conduct routine testing.
3. Conduct Safety functions testing.
4. Log observations and testing reports.

Maintenance and repair activities must be performed by skilled/trained technicians who have thorough knowledge of the system's working principles and the functions.

The main scope of maintenance and repair activities cover proof test of the safety function. However, the controller has built-in diagnostic functions which move system into a safe state when a fault is detected. Consideration should be given to check the functionality of all the safety-related fixed inputs.

Refer to Proof Tests on **page 17** for additional information on safety tests and normal operation tests.

In order to ensure smooth operation and reduce risk occurrence or hazardous events, the safety function of the controller should be checked every six (6) months.

The Fault Diagnostic System helps to diagnose and troubleshoot certain problems that may be experienced by the controller. Refer to the Fault Diagnostic System beginning on **page 69**. If test reveals that the controller does not work properly, the device must be replaced. There are **no serviceable parts** in the controller. Repairs are not permitted.

Appendix A: CAN Communication Protocol

Command List

Motor/Output	CAN ID	CAN Data	Data Qty	Notes
Brush Enable	00 00 00 01	1D F2 03 D1 D2	5	1D F2 03 00 00 Off 1D F2 03 00 01 On
Vacuum Enable	00 00 00 01	1D F9 01 D1 D2	5	1D F9 01 00 00 Off 1D F9 01 00 01 On
Brush Deck Enable	00 00 00 01	1D F5 01 D1 D2	5	1D F5 01 00 00 Off 1D F5 01 00 01 Up 1D F5 01 00 02 Down
Squeegee Enable	00 00 00 01	1D F6 01 D1 D2	5	1D F6 01 00 00 Off 1D F6 01 00 01 Up 1D F6 01 00 02 Down
Valve Enable	00 00 00 01	1D F7 03 D1 D2	5	1D F7 03 00 00 Off 1D F7 03 00 01 On
Reverse Alarm Enable	00 00 00 01	1D F7 05 D1 D2	5	1D F7 05 00 00 Off 1D F7 05 00 01 On
Aux1 Out Enable	00 00 00 01	1D F7 01 D1 D2	5	1D F7 01 00 00 Off 1D F7 01 00 01 On
Aux2 Out Enable	00 00 00 01	1D F8 01 D1 D2 D1: On/Off D2: Level	5	1D F8 01 00 00 Off 1D F8 01 01 00 On level-0 1D F8 01 01 03 On level-3
Brush Unload	00 00 00 01	1D F2 04 D1 D2	5	1D F2 04 00 00 Off 1D F2 04 00 01 On
Brush Load	00 00 00 01	1D F2 08 D1 D2	5	1D F2 08 00 00 Off 1D F2 08 00 01 On
Traction Direction	00 00 00 01	1D F1 04 D1 D2	5	1D F1 04 00 00 Neutral 1D F1 04 00 01 Forward 1D F1 04 00 02 Reverse
Traction Speed High	00 00 00 01	1D F1 00 00 00	5	
Traction Speed Medium	00 00 00 01	1D F1 01 00 00	5	
Traction Speed Low	00 00 00 01	1D F1 02 00 00	5	
Traction Direction	00 00 00 01	1D F1 04 00 00	5	1D F1 04 00 00 No 1D F1 04 00 01 Yes
Brush Speed High	00 00 00 01	1D F2 00 00 00	5	
Brush Speed Medium	00 00 00 01	1D F2 01 00 00	5	
Brush Speed Low	00 00 00 01	1D F2 02 00 00	5	
Brush Pressure High	00 00 00 01	1D F2 05 00 00	5	
Brush Pressure Medium	00 00 00 01	1D F2 06 00 00	5	
Brush Pressure Low	00 00 00 01	1D F2 07 00 00	5	

Controller Heartbeat Data (Status, Current, Voltage)

Controller will send out heartbeat data every 50 msec. Heartbeat data include controller status, motor current and voltage. Refer to the attached tables.

- **CAN ID:** 00 00 00 80
- **CAN Data:** 1D page D1 D2 D3 D4 D5 D6
- **Data Qty:** 8
- **1D:** Controller ID (Hex Value)
- **Page:** Runtime data page, Total 10 pages, 6 data/page

Order	Description	Calculation Formula
0	Vehicle State	
1	Error Value	
2	Input Flag	BIT, See b0-b7 Data Table
3	Input Flag1	BIT, See b0-b7 Data Table
4	Input Flag2	BIT, See b0-b7 Data Table
5	Input Flag3	BIT, See b0-b7 Data Table
6	Input Flag4	BIT, See b0-b7 Data Table
7	Input Flag5	BIT, See b0-b7 Data Table
8	Input Flag6	BIT, See b0-b7 Data Table
9	Input Flag7	BIT, See b0-b7 Data Table
10	Input Flag8	BIT, See b0-b7 Data Table
11	Input Flag9	BIT, See b0-b7 Data Table
12	Error Flag	BIT, See b0-b7 Data Table
13	Error Flag1	BIT, See b0-b7 Data Table
14	Desired Direction	0-Neutral, 1-Forward, 2-Reverse
15	Actual Direction	0-Neutral, 1-Forward, 2-Reverse
16	Bat Volt (16 Bit data)	/81 (Unit V)
17		
18	Heatsink Volt (Traction)	/81 (Unit V)
19	Heatsink Volt (Other)	/81 (Unit V)
20	Tract DDC	
21	Tract DDC	
22	Mosfet Temperature (Voltage)	
23	Brush Current	Unit A
24	Vacuum Current	Unit A
25	Squeegee Current	Unit A
26	Brush Deck Current	Unit A
27	Desired Bru Deck Direction	
28	Desired Squeegee Direction	
29	Water flow level	
30	Tract Left Current (16 Bit)	Unit A
31		
32	Tract left null current	
33		
34	Tract Right Current (16 Bit)	Unit A
35		

Order	Description	Calculation Formula
36	Tract right null current	
37		
38	MCU Temp Raw (16 Bit data)	$(1.412 - \text{MCU Temp Raw} * 3.3 / 4096) / 0.0043 + 25$ (Unit C)
39		
40	Vacuum DDC/12 V voltage	If vehicle state=drive enable state it is vacuum DDC else it is 12V voltage
41	Accelerator Raw	$*32 * 3.3 / 4096$ (Unit V)
42	Tract Left Drain Voltage	$*16 / 81$ (Unit V)
43	Tract Right Drain Voltage	$*16 / 81$ (Unit V)
44	Brush Drain Voltage	$*16 / 81$ (Unit V)
45	Vacuum Drain Voltage	$*16 / 81$ (Unit V)
46	Not used	
47	Not used	
48	Not used	
49	Firmware Major	
50	Firmware Minor	
51	Bat Type	
52	Vacuum Off Delay Time	
53	Not used	
54	Aux1 Drain Voltage	$*16 / 81$ (Unit V)
55	Aux2 Drain Voltage	$*16 / 81$ (Unit V)
56	Line Coil Voltage	$*16 / 81$ (Unit V)
57	Valve Drain Voltage	$*16 / 81$ (Unit V)
58	Brake Drain Voltage	
59	Not used	

Data Table: b0-b7

Flag	b0	b1	b2	b3	b4	b5	b6	b7
Input Flag	TRACT RUNNING	BRUSH RUNNING	VACUUM RUNNING	ACCEL SRO	BRAKE OPEN	CLEAN WATER EMPTY	DIRTY WATER FULL	
Input Flag1	OPERATOR PRESENCE BUF	EMS BUF	START BUF	AUX1 BUF	AUX2 BUF	AUX3 BUF	BRAKE ENABLE BUF	STEP BRAKE BUF
Input Flag2	TRACTION OPEN	BRUSH OPEN	VACUUM OPEN	ALARM ON	VALVE ON	AUX1 ON	AUX2 ON	BRAKE ON
Input Flag3	BRUSH ON	VACUUM ON	AUX1 ON	AUX2 ON	SQU UP LIMIT	SQU DOWN LIMIT	BRU-DECK UP LIMIT	BRU-DECK DOWN LIMIT
Input Flag4	CLEAN WATER BUF	DIRTY WATER BUF	VALVE ON	ALARM ON	FORWARD BUF	REVERSE BUF	BAT LOW	LCD WATCH FLAG
Input Flag5	Brush Unload ON	Brush Unload Complete	Brush Load On	Brush load Complete	P3 F1 High	P3 F1 Neutral	P3 F1 Low	P3 F2 High
Input Flag6	P3 F2 Neutral	P3 F2 Low	P3 F3 High	P3 F3 Neutral	P3 F3 Low	P3 F4 High	P3 F4 Neutral	P3 F4 Low
Input Flag7	P3 F5 High	P3 F5 Neutral	P3 F5 Low	P3 F11 High	P3 F11 Neutral	P3 F11 Low	P3 F12 High	P3 F12 Neutral
Input Flag8	P3 F12 Low	P3 F13 High	P3 F13 Neutral	P3 F13 Low	P2 F6 High	P2 F6 Neutral	P2 F6 Low	P2 F7 High
Input Flag9	P2 F7 Neutral	P2 F7 Low	P2 F13 High	P2 F13 Neutral	P2 F13 Low	P2 F14 High	P2 F14 Neutral	P2 F14 Low
Input Flag16	SQUEEGEE INIT FLAG	BRUSH DECK INIT FLAG	TURN BUF	BAT VERY LOW	ACCEL PRESSED	BRU DECK DOWN PROTECTION	AUX4 BUF	AUX5 BUF
Error Flag	TRACT ERROR	BRUSH ERROR	VAC ERROR	BRU-DECK ERROR	SQUEE ERROR	BRAKE ERROR	NO BRUSH ERROR	MOTOR STATE
Error Flag1	AUX1 ERROR	AUX2 ERROR	ALARM ERROR	VALVE ERROR	EEPROM ERROR	BRU ADJ ERROR	BAT CHARGE FLAG	BAT LOCKOUT

Dashboard Heartbeat Data to Controller

Dashboard must send heartbeat data to controller to keep communication with controller. If controller doesn't receive heartbeat data in 5 seconds, there will be communication error. All motors will be shut off under communication error. Here is a read-out:

CAN ID: 00 00 00 00
CAN Data: 1D D1 D2 D3 D4 D5 D6 D7
Data Qty: 8
1D: Controller ID
D1: SCREEN LOCK (If it is 1, the controller will be locked.)
D2: BAT LOW
D3: BAT VERY LOW
D4: DIRTY WATER FULL
D5: Water Flow Speed Limit
D6: Traction Speed Limit (0 – 100%)
D7: Tamper

Note: If Parameter (Control Mode) is set to 1, D1 – D7 is effective. Otherwise, D1-D7 is invalid.

Appendix B: Controller Parameters

There are 14 programmable inputs. Each input has a default function. The name represents its original function. However, there is also programmable multiplex functionality for each input.

For some special input functions, such as Slow Down (Turning) Switch, Squeegee Up Position Switch, Brush Down Protection Switch, etc., specified inputs can be programmed to these functions.

The following abbreviations are used in the Controller Parameters outline.

- NC – Normally Closed
- NO – Normally Open
- NW – Not Connected/ Wired

Numbers: 0 – 49

Parameter #: 0

Screen Name: Load default paraflg

Range: 0 – 1

Unit: Count

Description: Load to the default parameter or not.

0 – No

1 – Force to load default setting

Parameter #: 1

Screen Name: Customer_ID

Range: 0 – 255

Unit: Count

Description: Customer ID

0 – Superclean (CB-2007)

1 – ART

2 – Jiechi

3 – TVS

4 – Dongyu

5 – Weizhuo

6 – Jingri

7 – Yuli

8 – Chaobao (HY85B)

9 – ICE (Guobang)

10 – Haotian

11 – MICO

12 – Gadlee

99 – Test ID

(Tenant and Nilfisk to be added.)

Parameter #: 2

Screen Name: Machine ID

Range: 0 – 20

Unit: Count

Description: This is used for assigning a specific Machine ID on which the software is used. (To be added.)

Parameter #: 3

Screen Name: Control Mode

Range: 0 – 1

Unit: Count

Description: Control Mode used to select the type of interface the controller is using.

0 – Switch Control

1 – Virtual Control (Checks the heartbeat from the Front panel.)

Parameter #: 4

Screen Name: Dir. Input Function

Range: 0 – 2

Unit: Count

Description: Select the Direction Switch function.

0 – Direction

1 – Auto Mode

2 – Not Used

Parameter #: 5

Screen Name: Direction In type

Range: 0 – 5

Unit: Count

Description: Direction Switch Action functions.

0 – Two state (Normally, Open-Low Effective/low-RVS)

1 – Two state (Normally, Open-High Effective/High-RVS)

2 – Two state (Normally, Closed-Low Effective/Low-FWD)

3 – Two state (Normally, Closed-High Effective/High-FWD)

4 – Three state used in Direction SW (Low is reverse.)

5 – Three state used in Direction SW (High is reverse.)

Parameter #: 6

Screen Name: Direction SRO

Range: 0 – 1

Unit: On/Off

Description: Direction SRO check. Direction Static Return to Off. Reverse to the safety feature which prevents operation and complete power up of the controller, if certain conditions are not met. For the direction switch, it must be returned to the neutral position. If enabled, the direction must be neutral to pass the SRO conditions.

0 – Disabled (Check is bypassed.)

1 – Enabled

Parameter #: 7

Screen Name: Direction Lock Out

Range: 0 – 2

Unit: Count

Description: Direction locked. Limited use to prevent a direction change under certain conditions. The Function is invalid - No longer in service.

Parameter #: 8

Screen Name: Start Switch SRO

Range: 0 – 1

Unit: On/Off

Description: Start switch SRO check. Start switch Static Return to Off. Reverse to the safety feature which prevents the operation and complete powering up of the controller, if certain conditions are not met. For the start switch, it must be returned to the neutral position. Typically, this is used with a foot throttle, or the like. If enabled, the start switch must not be connected to pass the SRO conditions.

0 – Disabled (Check is bypassed.)

1 – Enabled

Parameter #: 9

Screen Name: Chat Period Time

Range: 0 – 255

Unit: Min

Description: Chat Timeout Period.

Parameter #: 10

Screen Name: Hour Meter Type

Range: 0 – 2

Unit: Count

Description: Hour Meter Type. Always ON after a self-test.

1 – Traction

2 – Scrubbing

Parameter #: 11

Screen Name: Sw Ref Voltage Type

Range: 0 – 1

Unit: Count

Description: SW input Ref voltage type 0 – 24V or 36V 1 – 5V.

Parameter #: 12

Screen Name: Engineer Debug Mode

Range: 0 – 1

Unit: Count

Description: Engineer Debug Mode.

0 – Disable

1 – Enable

Parameter #: 13

Screen Name: Mot temp in function

Range: 0 – 6

Unit: Count

Description: Motor temperature switch function (IN12).

- 0 – Motor temp
- 1 – Dirty water Switch
- 2 – Bru Auto Adj enable SW
- 3 – Beeper switch
- 4 – Water flow (DA)
- 5 – Brush pressure switch (DA)
- 6 – Motor temp switch

Parameter #: 14

Screen Name: Mot Temp sw Type

Range: 0 – 5

Unit: Count

Description: Valve input switch type (IN12) - Switch operation.

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 15

Screen Name: Battery Voltage

Range: 0 – 1

Unit: Count

Description: Battery Voltage Level - Select the battery level for the controller operation.

- 0 – 24V, typical operation range 21 – 28 volts
- 1 – 36, typical operation range 33 – 42 volts

Parameter #: 16

Screen Name: Battery Type

Range: 30 – 255

Unit: 0.1V

Description: ES_Battery_type. (To be added.)

Parameter #: 17

Screen Name: Battery voltage level 0

Range: 30 – 255

Unit: 0.1V

Description: Battery voltage level 0 threshold.

Parameter #: 18

Screen Name: Battery voltage level 1
Range: 30 – 255
Unit: 0.1V
Description: Battery voltage level 1 threshold.

Parameter #: 19
Screen Name: Battery voltage level 2
Range: 30 – 255
Unit: 0.1V
Description: Battery voltage level 2 threshold.

Parameter #: 20
Screen Name: Battery voltage level 3
Range: 30 – 255
Unit: 0.1V
Description: Battery voltage level 3 threshold.

Parameter #: 21
Screen Name: Battery voltage level 4
Range: 30 – 255
Unit: 0.1V
Description: Battery voltage level 4 threshold.

Parameter #: 22
Screen Name: Battery voltage level 5
Range: 30 – 255
Unit: 0.1V
Description: Battery voltage level 5 threshold.

Parameter #: 23
Screen Name: Accelerator Type
Range: 0 – 2
Unit: Count
Description: Accelerator type. This is the accelerator orientation for operation.

- 0 – No Accelerator used. This requires a forward and reverse switch to operate from 0 - full speed on selection of direction.
- 1 – Single-end type accelerator used. Single ended or line accelerator, the throttle runs from 0 to potentiometer make output resistance, i.e., a 5k linear throttle 0k to 5k resistance.
- 2 – Wig wag type accelerator used. A wig wag is a throttle that has both directions associated with one throttle without the use of a direction switch. This requires the throttle to be divided in half. 0 - 1/2 throttle reverse - 1/2 throttle to Max throttle Forward, i.e., 0 – 5k potentiometer 0 to 2.4K is reverse, dead band from 2.4 – 2.6K and then 2.6K – 5k is forward.

Parameter #: 24

Screen Name: Accel Resistance

Range: 0 – 8

Unit: Count

Description: Accelerator value used

ACCEL5K10K – Type of accelerator resistance typically used. These are standard resistances used for most operations. There are some that use 2.5k and dual inverted throttles for redundancy. However, those types are not support currently.

- 0 – 0K 0 - 5V accelerator! - Bypasses resistance limit checks.
- 1 – 5K 20% pot - Allowance for 20% Tolerance when doing resistance limit checks.
- 2 – 10K 20% pot - Allowance for 20% Tolerance when doing resistance limit checks.
- 3 – 5K 40% pot - Allowance for 40% Tolerance when doing resistance limit checks.
- 4 – 10K 40% pot - Allowance for 40% Tolerance when doing resistance limit checks.
- 5 – 5K 40%, two wire, for specified customer - Allowance for 40% Tolerance when doing resistance limit checks.
- 6 – 10K 40%, two wire, for specified customer - Allowance for 40% Tolerance when doing resistance limit checks.
- 7 – 5K 40%, for specified customer - Allowance for 40% Tolerance when doing resistance limit checks.
- 8 – 2.5K 40%, Inverted (Minuteman use that) - Allowance for 40% Tolerance when doing resistance limit checks.

Parameter #: 25

Screen Name: Accel Pot SRO

Range: 0 – 1

Unit: On/Off

Description: Accelerator pot SRO check. Accelerator Static Return to Off. Reverse to the safety feature which prevents the operation and complete powering up of the controller if certain conditions are not met. For the accelerator, it must be returned to the center for a wig wag or at the zero point for the linear throttle types. If enabled, the accelerator must be at a position that represents traction output voltage = 0 to pass the SRO conditions.

- 0 – Disabled (Check is bypassed.)
- 1 – Enabled

Parameter #: 26

Screen Name: Accel Upper Limit

Range: 1 – 100

Unit: % Max

Description: Acceleration upper limit. This is used only for Hall accelerator or a special resistance potentiometer. The upper limit corresponds to Max traction top speed. For a Hall accelerator, 100% is equal to 5V accelerator output. For a resistance potentiometer, 100% is equal to accelerator PWR. For example, if the hall accelerator output is only 0.6 – 2.5 V, then you can set Acceleration Upper Limit to 50%.

Parameter #: 27

Screen Name: Accel X Value

Range: 1 – 100

Unit: % Max

Description: Accelerator constants X. **Note:** This is the starting point of the “X” throttle shaping calculation based on a 0 – 100% scale of actual pot range. Refer to **Controller Parameters – Note 1** at the end of this section on **page 67** for a detailed example.

X, X1, X2, XR, XR1, XR2 is based on a 0 – 100% scale of actual pot range.

Y1, YR1 is based on a 0 – 100% scale of the top speed value.

Parameter #: 28

Screen Name: Accel X1 Value

Range: 1 – 100

Unit: % Max

Description: Accelerator constants X1. **Note:** This is the Midpoint (e.g., elbow, knee) of the “X” throttle shaping calculation based on a 0 – 100% scale of actual pot range. Refer to **Controller Parameters – Note 1** at the end of this section on **page 67** for a detailed example.

X, X1, X2, XR, XR1, XR2 is based on a 0 – 100% scale of actual pot range.

Y1, YR1 is based on a 0 – 100% scale of the top speed value.

Parameter #: 29

Screen Name: Accel X2 Value

Range: 1 – 100

Unit: % Max

Description: Accelerator constants X2. **Note:** This is the Midpoint (e.g., elbow, knee) of the “X” throttle shaping calculation based on a 0 – 100% scale of actual pot range. Refer to **Controller Parameters – Note 1** at the end of this section on **page 67** for a detailed example.

X, X1, X2, XR, XR1, XR2 is based on a 0 – 100% scale of actual pot range.

Y1, YR1 is based on a 0 – 100% scale of the top speed value.

Parameter #: 30

Screen Name: Accel Y1 Value

Range: 1 – 100

Unit: % Max

Description: Accelerator constants Y1. **Note:** This is the Speed point of the “X”, and the “XR” throttle shaping calculation based on a 0 – 100% scale of actual speed range. Refer to **Controller Parameters – Note 1** at the end of this section on **page 67** for a detailed example.

X, X1, X2, XR, XR1, XR2 is based on a 0 – 100% scale of actual pot range.

Y1, YR1 is based on a 0 – 100% scale of the top speed value.

Parameter #: 31

Screen Name: Accel XR Value

Range: 1 – 100

Unit: % Max

Description: Accelerator constants XR. **Note:** This is the starting point of the “XR” throttle shaping calculation based on a 0 – 100% scale of actual pot range. Refer to **Controller Parameters – Note 1** at the end of this section on **page 67** for a detailed example.

X, X1, X2, XR, XR1, XR2 is based on a 0 – 100% scale of actual pot range.

Y1, YR1 is based on a 0 – 100% scale of the top speed value.

Parameter #: 32

Screen Name: Accel XR1 Value

Range: 1 – 100

Unit: % Max

Description: Accelerator constants XR1. **Note:** This is the Midpoint (e.g., elbow, knee) of the “XR” throttle shaping calculation based on a 0 – 100% scale of actual pot range. Refer to **Controller Parameters – Note 1** at the end of this section on **page 67** for a detailed example.

X, X1, X2, XR, XR1, XR2 is based on a 0 – 100% scale of actual pot range.

Y1, YR1 is based on a 0 – 100% scale of the top speed value.

Parameter #: 33

Screen Name: Accel XR2 Value

Range: 1 – 100

Unit: % Max

Description: Accelerator constants XR2. **Note:** This is the Endpoint of the “XR” throttle shaping calculation based on a 0 – 100% scale of actual pot range. Refer to **Controller Parameters – Note 1** at the end of this section on **page 67** for a detailed example.

X, X1, X2, XR, XR1, XR2 is based on a 0 – 100% scale of actual pot range.

Y1, YR1 is based on a 0 – 100% scale of the top speed value.

Parameter #: 34

Screen Name: Accel YR1 Value

Range: 1 – 100

Unit: % Max

Description: Accelerator constants YR1. **Note:** This is the Speed point of the “X”, and the “XR” throttle shaping calculation based on a 0 – 100% scale of actual speed range. Refer to **Controller Parameters – Note 1** at the end of this section on **page 67** for a detailed example.

X, X1, X2, XR, XR1, XR2 is based on a 0 – 100% scale of actual pot range.

Y1, YR1 is based on a 0 – 100% scale of the top speed value.

Parameter #: 35

Screen Name: Tra Spd in function

Range: 0 – 1

Unit: Count

Description: Used to select the Direction switch function.

0 – As Traction Speed Switch input – traction.

1 – As Emergency Switch input. Emergency shutdown starts or Belly button.

Parameter #: 36

Screen Name: Tra spd sw type

Range: 0 - 5

Unit: Count

Description: Three state switch normally closed slow/medium/fast speed selection, Slow = Batt-; Medium = float or open; Fast = Batt+; OR Slow = Batt+; Medium = float or open; Fast = Batt-.

0 – Two state (Normally, open-low Effective/low-RVS)

1 – Two state (Normally, open-High Effective/High-RVS)

2 – Two state (Normally, closed-Low Effective/Low-FWD)

3 – Two state (Normally, closed-High Effective/High-FWD)

4 – Three state used in direction SW (Low is reverse)

5 –Three state used in direction SW High is reverse)

Parameter #: 37

Screen Name: T Speed type

Range: 0 – 3

Unit: Count

Description: Traction Speed Control Mode. The operation of the speed control.

0 – No speed switch/pot

1 – Slow/Fast switch

2 – By panel (Heartbeat)

3 – By panel (CAN CMD)

Parameter #: 38

Screen Name: T Direction type

Range: 0 – 1

Unit: Count

Description: Traction Direction Control Mode. How the traction input is selected and where it comes from.

0 – By input SW

1 – By panel

Parameter #: 39

Screen Name: Trac Topspeed F

Range: 1 – 100

Unit: % Bat

Description: Traction top speed forward. The maximum speed allowed. It is also the maximum speed if multiple speed selections are used, such as slow and medium speeds.

Parameter #: 40

Screen Name: Trac MedSpeed F

Range: 1 – 100

Unit: % Bat

Description: Traction medium speed forward. If multiple speed selections are enabled, this is the medium speed allowed.

Parameter #: 41

Screen Name: Trac LowSpeed F

Range: 1 – 100

Unit: % Bat

Description: Traction low speed forward. If multiple speed selections are enabled, this is the slow speed allowed.

Parameter #: 42

Screen Name: Trac Topspeed R

Range: 1 – 100

Unit: % Bat

Description: Traction top speed reverse. The maximum speed allowed. It is also the maximum speed if multiple speed selections are used, such as slow and medium speeds.

Parameter #: 43

Screen Name: Trac MedSpeed R

Range: 1 – 100

Unit: % Bat

Description: Traction medium speed reverse. If multiple speed selections are enabled, this is the medium speed allowed.

Parameter #: 44

Screen Name: Trac LowSpeed R

Range: 1 – 100

Unit: % Bat

Description: Traction low speed reverse. If multiple speed selections are enabled, this is the slow speed allowed.

Parameter #: 45

Screen Name: T Lo Batt Topspeed

Range: 1 – 100

Unit: % Bat

Description: Traction low battery top speed. When the battery reaches the low battery limit. All speeds are set to this low battery speed regardless of High, medium, or low speed selection. Another term for this is "Limp Home Mode".

Parameter #: 46

Screen Name: T Accel Forward

Range: 1 – 100

Unit: 0.1 Sec

Description: Traction acceleration forward. The ramp rate is the length of time it takes the controller to reach the target set point. The higher the number, the faster the vehicle will be able to accelerate. Conversely, the lower the value, the longer it will take to get to the set point.

Parameter #: 47

Screen Name: T Accel Reverse

Range: 1 – 100

Unit: 0.1 Sec

Description: Traction acceleration reverse. The ramp rate is the length of time it takes the controller to reach the target set point. The higher the number, the faster the vehicle will be able to accelerate. Conversely, the lower the value, the longer it will take to get to the set point.

Parameter #: 48

Screen Name: T Decel Forward

Range: 1 – 100

Unit: 0.1 Sec

Description: Traction deceleration forward. The ramp rate is the length of time it takes the controller to reach the target set point. The higher the number, the faster the vehicle will be able to accelerate. Conversely, the lower the value, the longer it will take to get to the set point.

Parameter #: 49

Screen Name: T Decel Reverse

Range: 1 – 100

Unit: 0.1 Sec

Description: Traction deceleration reverse. The ramp rate is the length of time it takes the controller to reach the target set point. The higher the number, the faster the vehicle will be able to accelerate. Conversely, the lower the value, the longer it will take to get to the set point.

Numbers: 50 – 99

Parameter #: 50

Screen Name: T Keyoff Decel

Range: 1 – 100

Unit: 0.1 Sec

Description: Traction key off deceleration ramp. The ramp rate is the length of time it takes the controller to reach stop. The higher the number, the faster the vehicle will be able to accelerate. Conversely, the lower the value, the longer it will take to stop. This is used when the Key is turned off. The vehicle will attempt to slow down at a controlled set rate. This is typically a faster deceleration rate.

Parameter #: 51

Screen Name: T No Start SW decel

Range: 1 – 100

Unit: 0.1 Sec

Description: Traction no start switch deceleration. The ramp rate is the length of time it takes the controller to reach stop. The higher the number, the faster the vehicle will be able to accelerate. Conversely, the lower the value, the longer it will take stop. This is used to control the deceleration, if the throttle start switch input is removed by a fault or by the user.

Parameter #: 52

Screen Name: T Brake On Accel

Range: 1 – 100

Unit: 0.1 Sec

Description: Traction deceleration rate before traction current < 0, else deceleration will use the above forward/reverse deceleration rate. This is used in conjunction with a brake switch input. If no brake switch input is used, this is ignored.

Parameter #: 53

Screen Name: Traction I Limit

Range: 1 – 160

Unit: Amp

Description: Traction stall current limit. This is the set point that limits the amount of current to the motor. The controller will go into Protection Mode first by limiting or reducing the current, or fault, if the current cannot be corrected.

Parameter #: 54

Screen Name: T Accel Stall Time

Range: 1 – 250

Unit: 0.1 Sec

Description: Traction acceleration stall time. Up/Down counter that counts how long the traction has been above 90% current limit. If the controller drops below the limit, the counter counts back to zero. This is a "locked" rotor test.

Parameter #: 55

Screen Name: T Decel Stall Time

Range: 1 – 10

Unit: 0.1 Sec

Description: Traction deceleration stall time. Up/Down counter that counts how long the traction has been above 90% current limit. If the current drops below the limit, the counter counts back to zero. This is a "locked" rotor test.

Parameter #: 56

Screen Name: Traction turn on decel Level 1

Range: 1 – 100

Unit: Count

Description: The level 1 deceleration rate of traction turn On.

Parameter #: 57

Screen Name: Traction turn on decel Level 2

Range: 1 – 100

Unit: Count

Description: The level 2 deceleration rate of traction turn On.

Parameter #: 58

Screen Name: Traction control by vacuum

Range: 0 – 1

Unit: Count

Description: Traction on control by vacuum.

0 – Disable

1 – Enable

Parameter #: 59

Screen Name: Traction driverless mode

Range: 0 – 1

Unit: Count

Description: Traction Driverless Mode.

0 – Disable

1 – Enable

Parameter #: 60

Screen Name: LimpHome Traction Speed

Range: 10 – 90%

Unit: %

Description: Describes the fixed percentage of traction top speed when a brush deck related fault is detected (default – 50% of top speed).

Parameter #: 61

Screen Name: Brush S Limit

Range: 10 – 190

Unit: Amp

Description: Describes brush output software protection current limit.

Parameter #: 62

Screen Name: Bru Spd input Func

Range: 0 – 4

Unit: Count

Description: Brush speed selection and use or alternate functions, if needed.

- 0 – No speed switch/pot
- 1 – Slow/Fast switch
- 2 – Auto Mode
- 3 – Clean water SW
- 4 – Brush down switch

Parameter #: 63

Screen Name: Bru spd sw type

Range: 0 – 5

Unit: Count

Description: Three state switch normally closed slow/medium/fast speed selection, Slow = Batt-; Medium = float or open; Fast = Batt+; OR Slow = Batt+; Medium = float or open; Fast = Batt-. Selected by the Brush Speed input switch.

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 64

Screen Name: Bru SW In Function

Range: 0 – 2

Unit: Count

Description: Brush switch function.

- 0 – Not used
- 1 – Brush switch
- 2 – Brush Deck Up Limit SW

Parameter #: 65

Screen Name: Bru SW In Type

Range: 0 – 5

Unit: Count

Description: Valve input switch type - Switch operation.

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 66

Screen Name: Brush Top Speed

Range: 0 – 60

Unit: V

Description: Brush motor top speed. The set point at which the brush voltage is limited.

Parameter #: 67

Screen Name: Brush medium speed

Range: 0 – 60

Unit: V

Description: Brush motor top speed. The set point at which the brush medium voltage is limited, if multiple voltage set points are used.

Parameter #: 68

Screen Name: Brush Low speed

Range: 0 - 60

Unit: V

Description: Brush motor low speed. The set point at which the brush Low voltage is limited, if multiple voltage set points are used.

Parameter #: 69

Screen Name: Bru Enabled by accel

Range: 0 – 3

Unit: Count

Description: If Brush motor enabled by accelerator/traction.

0 – No

1 – By traction output

2 – By accelerator output

3 – By tract ADC

Parameter #: 70

Screen Name: Bru off in RVS

Range: 0 – 1

Unit: Count

Description: This specifies whether the brush is disabled in reverse direction.

0 – No. If the brush is running in forward and the vehicle is placed in reverse, the brush will continue to spin.

1 – Yes. If the is running in the forward direction and the vehicle is placed in reverse, the brush will stop spinning. Typically, this is used with Brush deck actuator to raise the deck slightly off the floor.

Parameter #: 71

Screen Name: Brush Accel Rate

Range: 1 – 100

Unit: 0.1 Sec

Description: Brush motor acceleration rate. The ramp rate is the length of time it takes the controller to reach the target set point. The higher the number, the faster the brush will accelerate. Conversely, the lower the value, the longer it will take to get to the set point.

Parameter #: 72

Screen Name: Brush Decel Rate

Range: 1 – 100

Unit: 0.1 Sec

Description: Brush motor deceleration rate. The ramp rate is the length of time it takes the controller to reach the target set point. The higher the number, the faster the brush will decelerate. Conversely, the lower the value, the longer it will take to get to the set point.

Parameter #: 73

Screen Name: Keyoff B Decel Rate

Range: 1 – 100

Unit: 0.1 Sec

Description: Brush motor key off deceleration rate. The ramp rate is the length of time it takes the controller to reach stop. The higher the number, the faster the vehicle will accelerate. Conversely, the lower the value, the longer it will take to get to the set point. This is used when the Key is turned off. The brush will attempt to slow down at a controlled set rate. This is typically a faster deceleration rate.

Parameter #: 74

Screen Name: Bru Unload Decel Rate

Range: 1 – 100

Unit: 0.1 Sec

Description: Brush motor unload deceleration rate, (Use rapid deceleration to unload brush.) This is the time it takes for the brush to slow down when the brush scrub pressure needs to be reduced.

Parameter #: 75

Screen Name: Bru Load Accel Rate

Range: 1 – 200

Unit: 0.1 Sec

Description: Brush motor acceleration rate during loading. This is the time it takes for the brush to accelerate up when the brush scrub pressure needs to be increased.

Parameter #: 76

Screen Name: Bru Load down Time

Range: 1 – 150

Unit: 0.1 Sec

Description: Brush motor down time during loading. The amount of time the Brush Deck actuator is to be actively lowering the deck.

Parameter #: 77

Screen Name: Bru Load Current

Range: 1 – 50

Unit: A

Description: Brush motor current target for judgment of brush loading successfully. It is the brush current set point for optimal scrubbing.

Parameter #: 78

Screen Name: Brush Current Limit

Range: 1 – 190

Unit: A

Description: Brush motor stall current limit. The Up/Down counter that counts how long the traction has been above 90% current limit. If the controller drops below the limit, the counter counts back to zero. This is a "locked" rotor test.

Parameter #: 79

Screen Name: B Accel Stall Time

Range: 1 – 100

Unit: 0.1 Sec

Description: Brush motor acceleration stall time limit. The Up/Down counter that counts how long the Brush has been above 90% current limit. If the controller drops below the limit, the counter counts back to zero. This is a "locked" rotor test.

Parameter #: 80

Screen Name: Bru software control

Range: 0 – 3

Unit: Count

Description: This is the brush motor software control used by brush deck motor. It is customer-specific. (To be added.)

Parameter #: 81

Screen Name: Bru Adjust function

Range: 0 – 9

Unit: Count

Description: Brush motor pressure auto adjustment function used. The setting position depends on the parameter (brush down Stop Mode). It can be set to be controlled by time or by switch.

0 – Not enabled.

1 – Enabled (Start continuous adjustment using brush-on signal).

2 – Used by specified customer.

3 – Enabled (The brush moves down to the setting position using brush-on signal and start continuous adjustment by traction/accelerator which depend on the "Bru Enabled by accel" parameter.)

4 – Used by specified customer.

5 – Used by specified customer.

Parameter #: 82

Screen Name: Bru Pressure target1

Range: 0 – 50

Unit: A

Description: Brush motor pressure current Target 1, when the brush motor pressure auto adjustment function is enabled. Set point for brush current. Brush Current is related to scrubbing force or pressure. The more current the brush needs to continue to spin, the harder the brush is pressing on the floor. Thus, the more "scrubbing" is done.

Parameter #: 83

Screen Name: Bru Pressure target2

Range: 1 – 50

Unit: A

Description: Brush motor pressure current Target 2, when brush motor pressure auto adjustment function is enabled. Set point for brush current. Brush Current is related to scrubbing force or pressure. The more current the brush needs to continue to spin, the harder the brush is pressing on the floor. Thus, the more "scrubbing" is done.

Parameter #: 84

Screen Name: Bru Pressure target3

Range: 1 – 50

Unit: A

Description: Brush motor pressure Target 3, when brush motor pressure auto adjustment function is enabled. Set point for brush current. Brush Current is related to scrubbing force or pressure. The more current the brush needs to continue to spin, the harder the brush is pressing on the floor. Thus, the more "scrubbing" is done.

Parameter #: 85

Screen Name: Bru Pressure tol

Range: 1 – 20

Unit: A

Description: Brush motor pressure adjustment current tolerance. This is the window around the brush pressure for Target 1, 2, and 3. The smaller the window set, the faster and more frequent the brush current and the deck actuator are adjusted to maintain the scrubbing action.

Parameter #: 86

Screen Name: No Bru I target

Range: 0 – 50

Unit: A

Description: No brush judgment criteria (current target). This is used when the brush motor pressure auto adjustment function is enabled. If the brush current is too low, (possibly No Pad or some other condition that would cause low brush current), the brush will be shut down. It is used with No Brush time below.

Parameter #: 87

Screen Name: No_Brush_Time

Range: 0 – 255

Unit: Sec

Description: No brush judgment criteria (current target) when the brush motor pressure auto adjustment function is enabled. If the brush current is too low, then possibly No Pad or some other condition that would cause low brush current. The brush will be shut down.

Parameter #: 88

Screen Name: Bru Adj. Time Const.

Range: 1 – 300

Unit: Count

Description: Brush current check filter time during Brush Pressure Adjustment. This is the delay time used to allow the brush to stabilize and the amount of reaction time the desired for the operation, i.e., the faster/slower response of pressure adjustments.

Parameter #: 89

Screen Name: Bru Adj Factor

Range: 1 – 20

Unit: Count

Description: Brush pressure adjustment factor. This is the reaction time of the brush adjustments. The longer the time entered, the slower the brush reaction time. Vice versa for faster time (lower number).

Parameter #: 90

Screen Name: Bru off-clean empty

Range: 0 – 1

Unit: Count

Description: This determines whether the brush motor is disabled when clean water is empty.

Parameter #: 91

Screen Name: Brush install speed

Range: 1 – 100

Unit: %

Description: Brush install speed. (To be added.)

Parameter #: 92

Screen Name: Brush loss over alarm

Range: 0 – 1

Unit: Count

Description: Brush on control by no brush error.

0 – Disable

1 – Enable

Parameter #: 93

Screen Name: Vacuum S Limit

Range: 10 – 80

Unit: Amp

Description: Vacuum output software protection current limit.

Parameter #: 94

Screen Name: Vac SW In Function

Range: 0 – 2

Unit: Count

Description: Vacuum switch input selection function.

0 – Not used

1 – Vacuum switch

2 – Squeegee Up limit SW

Parameter #: 95

Screen Name: Vac SW In Type

Range: 0 – 5

Unit: Count

Description: Valve input switch type - Switch operation.

0 – Two state (Normally, open-low Effective/low-RVS)

1 – Two state (Normally, open-High Effective/High-RVS)

2 – Two state (Normally, closed-Low Effective/Low-FWD)

3 – Two state (Normally, closed-High Effective/High-FWD)

4 – Three state used in direction SW (Low is reverse)

5 – Three state used in direction SW (High is reverse)

Parameter #: 96

Screen Name: Vacuum Topspeed

Range: 1 – 60

Unit: V

Description: Vacuum motor top speed. This is the vacuum motor top speed as per the maximum set voltage.

Parameter #: 97

Screen Name: Vac Enabled by accel

Range: 0 – 3

Unit: Count

Description: Vacuum motor output enabled by accelerator output.

0 – No

1 – By traction output

2 – By accelerator output

3 – By tract ADC

Parameter #: 98

Screen Name: Vac off in RVS

Range: 0 – 1

Unit: Count

Description: This determines whether the vacuum motor is disabled during reverse direction.

0 – No, the vacuum will remain "On" when the direction of travel has changed from forward to reverse.

1 – Yes, the vacuum will be de-energized when the direction of travel has changed from forward to reverse for the duration of the time in reverse, until the direction returns to forward.

Parameter #: 99

Screen Name: Vacuum Accel Rate

Range: 1 – 100

Unit: 0.1 Sec

Description: Vacuum motor acceleration rate. This is the rate at which the vacuum will increase to reach the set point. The larger the number, the faster the controller will reach the set voltage. Conversely, the lower the value, the slower the controller will reach the set point.

Numbers: 100 – 149

Parameter #: 100

Screen Name: Vacuum Decel Rate

Range: 1 – 100

Unit: 0.1 Sec

Description: Vacuum motor deceleration rate. This is the rate at which the controller will decelerate the vacuum voltage when turned off. The larger the number, the faster the controller will reach the set voltage. Conversely, the lower the value, the slower the controller will reach the set point.

Parameter #: 101

Screen Name: Keyoff Vac Decel

Range: 1 – 100

Unit: 0.1 Sec

Description: Vacuum key off deceleration rate - The ramp rate is the length of time it takes the controller to reach stop. The higher the number, the faster the vehicle will decelerate. Conversely, the lower the value, the longer it will take to stop. This is used when the Key is turned off. The vacuum slows down at a controlled set rate. It is typically a faster deceleration rate.

Parameter #: 102

Screen Name: Vacuum Current Limit

Range: 1 – 80

Unit: Amp

Description: Vacuum motor stall current limit. This is the set point that limits the amount of current to the motor. The controller will transition into Protection Mode first by limiting or reducing the current, or fault if the current cannot be corrected.

Parameter #: 103

Screen Name: Vac Accel Stall Time

Range: 1 – 100

Unit: 0.1 Sec

Description: Vacuum motor acceleration stall time limit – This is the Up/Down counter that counts how long the traction has been above 90% current limit. If the controller drops below the limit, the counter counts back to zero. This is a "locked" rotor test.

Parameter #: 104

Screen Name: Vac software control

Range: 0 – 2

Unit: Count

Description: This indicates whether the vacuum motor is controlled by the squeegee motor. The location of the squeegee determines if the vacuum is Off or On. Up = Off, down = On. (This is customer-specific.)

Parameter #: 105

Screen Name: Vacuum Start delay

Range: 0 – 60

Unit: Sec

Description: Vacuum motor start delay time. This is the delay time between the vacuum being enabled and the vacuum actually starting, which allows some time for the squeegee to lower and water to accumulate in the squeegee.

Parameter #: 106

Screen Name: Vacuum Off delay

Range: 0 – 60

Unit: Sec

Description: Vacuum motor stop delay time. This is the delay time for the Squeegee to allow any excess water to be acquired by the vacuum to prevent back-flow or dripping from the vacuum tubes.

Parameter #: 107

Screen Name: Vac off-dirty full

Range: 0 – 1

Unit: Count

Description: This determines whether the vacuum motor is disabled when the dirty water reservoirs is full. (To be added.)

Parameter #: 108

Screen Name: Vacuum mode enable

Range: 0 – 1

Unit: Count

Description: This configures the Vacuum Mode. Other functions of the machine could be disabled during this mode.

0 – Vacuum Mode disabled.

1 – Vacuum Mode enabled.

Parameter #: 109

Screen Name: Squeegee S Limit

Range: 2 – 10

Unit: Amp

Description: This specifies the squeegee output software protection current limit.

Parameter #: 110

Screen Name: Squee Top speed

Range: 1 – 60

Unit: V

Description: Squeegee Top speed. This sets the maximum voltage applied to the squeegee actuator. This increases the speed at which the actuator will raise or lower.

Parameter #: 111

Screen Name: Squee up by RVS

Range: 0 – 7

Unit: Count

Description: This indicates whether the squeegee is forced to be lifted during reverse direction.

- 0 – No, No Squeegee action is taken if the direction of travel is changed from forward to reverse.
- 1 – Yes, the squeegee is raised with no delay after traction direction change is detected.
- 2 – Yes, The squeegee is raised with the direction of travel change, but is delayed by 1 second.
- 3 – Yes, the squeegee is raised with the direction of travel change, but is delayed by "X" seconds based on count number entered. 0 - 6 seconds. Max delay time = 6 seconds. (To be verified.)

Parameter #: 112

Screen Name: Squ Acc/Dec Rate

Range: 4 – 100

Unit: 0.1 Sec

Description: Squeegee motor acceleration/deceleration rate. The ramp rate is the length of time it takes the controller to reach the target set point. The higher the number, the faster the squeegee will be able to accelerate. Conversely, the lower the value, the longer it will take to get to the set point.

Parameter #: 113

Screen Name: Squee Current Limit

Range: 1 – 9

Unit: A

Description: Squeegee motor stall current limit. The set point limits the amount of current to the motor. The controller will move into Protection Mode first by limiting or reducing the current, or fault if the current cannot be corrected.

Parameter #: 114

Screen Name: Squee Accel Stall T

Range: 1 – 100

Unit: 0.1 Sec

Description: Squeegee motor acceleration stall time limit. The set point limits the amount of current to the motor. The controller will go into Protection Mode first by limiting or reducing the current, or fault if the current cannot be corrected.

Parameter #: 115

Screen Name: Squee up delay

Range: 0 – 30

Unit: Sec

Description: This is the delay time before the Squeegee motor starts to go up. It allows the squeegee to remain on the floor a few extra seconds to collect the water on the floor after scrubbing is complete. This is usually used with the Vacuum delay.

Parameter #: 116

Screen Name: Squee down delay

Range: 0 – 30

Unit: Sec

Description: This is the delay time before the Squeegee motor start to go down. A lower delay allows the scrubber water flow to start before the squeegee is lowered.

Parameter #: 117

Screen Name: Squee control by vac

Range: 0 – 1

Unit: Count

Description: This indicates whether the squeegee motor is controlled by the Vacuum motor.

0 – No, The squeegee will raise or lower based on the input.

1 – Yes, If the vacuum is turned on, then the squeegee will lower to the floor. If the vacuum is turned off, the squeegee will raise again.

Parameter #: 118

Screen Name: Squee up stop mode

Range: 0 – 4

Unit: Count

Description: Stop Mode for squeegee going up.

0 – Do not stop until there is a stop command. The controller will continually energize the actuator motor until it detects an over current or an open switch on the actuator.

1 – Stop by time (available for the squeegee motor with auto shut down function). A timed operation, the squeegee will operate for the set time-period and then shut off.

2 – Stop by squeegee current limit (the current can be set separately). Once the actuator senses the current has exceeded the set limit, the actuator is shut down, typically due to blockage or physical mechanical limits.

3 – Stop by time + current. The setting uses both current and time to stop the actuator.

- 4 – Stop by up position switch (Program input is needed to select the function as squeegee up position switch). The actuator is enabled only by a physical switch input. If the switch is opened/closed (depending on logic used), the actuator will stop operation.

Parameter #: 119

Screen Name: Squee down stop mode

Range: 0 – 4

Unit: Count

Description: Stop Mode for the squeegee going down.

- 0 – Do not stop until there is stop command. The controller will continually energize the actuator motor until it has seen an over current or an open switch on the actuator.
- 1 – Stop by time (Available for the squeegee motor with auto shut down function). A timed operation, the squeegee will operate for the set time-period and then shut off.
- 2 – Stop by squeegee current limit (the current can be set separately). Once the actuator senses the current has exceeded the set limit, the actuator is shut down due to blockage or physical mechanical limits.
- 3 – Stop by time + current. The setting uses both current and time to stop the actuator. The actuator is enabled only by a physical switch input. If the switch is opened/closed (depending on logic used), the actuator will stop operation.
- 4 – Stop by down position switch (Program input is needed to select the function as squeegee down position switch).

Parameter #: 120

Screen Name: Squ up stop time

Range: 0 – 200

Unit: 0.1 Sec

Description: This is the stop time for squeegee going up and is used when Squee Up Stop Mode is set to 1 or 3.

Parameter #: 121

Screen Name: Squ down stop time

Range: 0 – 100

Unit: 0.1 Sec

Description: This is the stop time for squeegee going down and is used when Squee Down Stop Mode is set to 1 or 3.

Parameter #: 122

Screen Name: Squee up stop I Lim

Range: 1 – 8

Unit: Amp

Description: This is the stop current limit for squeegee going up and is used when Squee Up Stop Mode is set to 2 or 3.

Parameter #: 123

Screen Name: Squee down stop I Lim

Range: 1 – 8

Unit: Amp

Description: This is the stop current limit for squeegee down and is used when Squee Up Stop Mode is set to 2 or 3.

Parameter #: 124

Screen Name: Squee SW in function

Range: 0 – 3

Unit: Count

Description: Brush deck switch function.

- 0 – Not used.
- 1 – Squeegee SW.
- 2 – Turn Switch.

Parameter #: 125

Screen Name: Squee sw type

Range: 0 – 5

Unit: Count

Description: Squeegee input switch type – Switch operation.

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 126

Screen Name: Bru-Deck S Limit

Range: 2 – 10

Unit: Amp

Description: This indicates the brush deck control output software protection current limit.

Parameter #: 127

Screen Name: Bru-D Sw in Function

Range: 0 – 2

Unit: Count

Description: This is used to select the Direction switch function.

- 0 – Not used
- 1 – Bru Deck SW
- 2 – Brush Deck Down Switch

Parameter #: 128

Screen Name: Bru-D sw type

Range: 0 – 5

Unit: Count

Description: Selects switch as an input to enable brush or enable the brush protection.

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 129

Screen Name: Bru Deck Topspeed

Range: 0 – 60

Unit: V

Description: Brush deck motor top speed. This is for normal running of the brush deck motor. During brush pressure auto adjustment, the brush deck speed is controlled by these two parameters:

Bru_D Max Adj Volt and Bru_D Min Adj Volt

Parameter #: 130

Screen Name: Bru_D Max Adj Volt

Range: 1 – 36

Unit: V

Description: This is the maximum brush deck adjustment voltage in the brush pressure auto adjustment function. The brush will attempt to maintain the voltage.

Parameter #: 131

Screen Name: Bru_D Min Adj Volt

Range: 1 – 36

Unit: V

Description: This is the minimum brush deck adjustment voltage in the brush pressure auto adjustment function. The brush will attempt to maintain the voltage.

Parameter #: 132

Screen Name: Bru-deck up by RVS

Range: 0 – 1

Unit: Count

Description: Brush deck up in Reverse. If = 1, then the brush deck will raise when the direction is changed to reverse and for the duration of the reverse operation. When the direction is changed to forward, the brush is lowered and resumes the preset operation conditions.

- 0 – Disabled
- 1– The brush deck will raise when the direction is changed to reverse, and for the duration of the reverse operation. When the direction is changed to forward, the brush is lowered and then resumes the preset operation conditions.

Parameter #: 133

Screen Name: Bru-D Acc/Dec Rate

Range: 4 – 100

Unit: 0.1 Sec

Description: Brush deck motor acceleration/deceleration rate. The ramp rate is the length of time it takes the controller to reach the target set point. The higher the number, the faster the brush deck will be able to accelerate. Conversely, the lower the value, the longer it will take to get to the set point.

Parameter #: 134

Screen Name: Bru-D Current Limit

Range: 1 – 9

Unit: A

Description: Brush deck motor stall current limit. The set point limits the amount of current to the motor. The controller will go into Protection Mode first by limiting or reducing the current, or fault if the current cannot be corrected.

Parameter #: 135

Screen Name: Bru-D Accel Stall T

Range: 1 – 100

Unit: 0.1 Sec

Description: Brush deck motor acceleration stall time limit. This is the Up/Down counter that counts how long the traction has been above 90% current limit. If the controller drops below the limit, the counter counts back to zero. This is a "locked" rotor test.

Parameter #: 136

Screen Name: Bru Deck up delay

Range: 0 – 30

Unit: Sec

Description: Delay time before Squeegee motor starts to go up. This is the amount of time delay to raise the deck, allowing the deck to remain on the floor a few extra seconds to scrub.

Parameter #: 137

Screen Name: Bru-Deck down delay

Range: 0 – 30

Unit: Sec

Description: Delay time before Squeegee motor starts to go down. The delay to lower the Deck allowing the deck to remain lifted while traction starts.

Parameter #: 138

Screen Name: Bru-D up stop mode

Range: 0 – 4

Unit: Count

Description: Stop Mode for squeegee going up.

- 0 – Do not stop until there is stop command.
- 1 – Stop by time (Available for the squeegee motor with auto shut down function).
- 2 – Stop by Brush deck current limit (the current can be set separately).
- 3 – Stop by time + current.
- 4 – Stop by up position switch (Program input is needed to select the function as the squeegee up position switch).

Parameter #: 139

Screen Name: Bru-D down stop mode

Range: 0 – 5

Unit: Count

Description: Stop Mode for squeegee going down.

- 0 – Do not stop until there is stop command.
- 1 – Stop by time (Available for the squeegee motor with auto shut down function).
- 2 – Stop by Brush deck current limit (The current can be set separately).
- 3 – Stop by time + current.
- 4 – Stop by up position switch (Program input is needed to select the function as the squeegee up position switch). (To be added.)

Parameter #: 140

Screen Name: Bru-D up stop time

Range: 0 – 200

Unit: 0.1 Sec

Description: Stop time for brush deck motor going up. This is used when Squee Up Stop Mode is set to 1 or 3.

Parameter #: 141

Screen Name: Bru-D down stop time

Range: 0 – 200

Unit: 0.1 Sec

Description: Stop time for she squeegee motor going down. This is used when Bru-D Down Stop Mode is set to 1 or 3.

Parameter #: 142

Screen Name: Bru-D up stop I Lim

Range: 1 – 8

Unit: A

Description: Stop current limit for the brush deck motor going up. This is used when Bru-D Up Stop Mode is set to 3.

Parameter #: 143

Screen Name: Bru-D down stop I Lim

Range: 1 – 25

Unit: A

Description: Stop current limit for the brush deck motor going down. This is used when Bru-D Up Stop Mode is set to 3.

Parameter #: 144

Screen Name: Brush deck Enable Used

Range: 0 – 1

Unit: Count

Description: Brush deck is used.

0 – Disable

1 – Enable

Parameter #: 145

Screen Name: Aux 1 Input Function

Range: 0 – 11

Unit: Count

Description: Describes what the input is to do when selected.

0 – Not used

1 – Normal Aux1 input

2 – Start SW

3 – Seat SW

4 – Brake enable SW

5 – BRUSH PRESSURE SW

6 – EMS SW

7 – Cruise Control SW

8 – Mechanical Braker SW

9 – Direction

10 – Clean water SW

11 – Beeper Switch

Parameter #: 146

Screen Name: Aux1 in switch type

Range: 0 – 5

Unit: Count

Description: Describes the level of input the switch can select. The controller inputs can be selected in 3 typical states: High (Batt+), Mid (float or Open switch), Low (0 or Batt-).

0 – Two state (Normally, open-low Effective/low-RVS)

1 – Two state (Normally, open-High Effective/High-RVS)

2 – Two state (Normally, closed-Low Effective/Low-FWD)

3 – Two state (Normally, closed-High Effective/High-FWD)

4 – Three state used in direction SW (Low is reverse)

5 – Three state used in direction SW (High is reverse)

Parameter #: 147

Screen Name: Aux 2 Input Function

Range: 0 – 12

Unit: Count

Description: Describes what the input is to do when selected.

- 0 – Not used
- 1 – Normal Aux2 input
- 2 – Start SW
- 3 – Seat SW
- 4 – Brake enable SW
- 5 – BRUSH PRESSURE SW
- 6 – EMS SW
- 7 – Cruise Control SW
- 8 – Mechanical Braker SW
- 9 – Auto Mode
- 10 – Dirty water SW
- 11 – Brush down limit switch
- 12 – Beeper Switch

Parameter #: 148

Screen Name: Aux 2 in switch type

Range: 0 – 5

Unit: Count

Description: Describes the level of input the switch can select. The controller inputs can be selected in 3 typical state High (Batt +), Mid (float or Open switch), Low (0 or Batt -).

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 149

Screen Name: Aux 3 Input Function

Range: 0 – 11

Unit: Count

Description: Describes what the input is to do when selected.

- 0 – Not used
- 1 – Normal Aux3 input
- 2 – Start SW
- 3 – Seat SW
- 4 – Brake enable SW
- 5 – BRUSH PRESSURE SW
- 6 – EMS SW
- 7 – Cruise Control SW
- 8 – Mechanical Braker SW
- 9 – turn SW
- 10 – Step-on Brake SW
- 11 – Beeper Switch

Numbers: 150 – 195

Parameter #: 150

Screen Name: Aux 3 in switch type

Range: 0 – 5

Unit: Count

Description: Describes the level of input the switch can select. The controller inputs can be selected in 3 typical states: High (Batt+), Mid (float or Open switch), Low (0 or Batt-).

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 151

Screen Name: Aux 4 Input Function

Range: 0 – 8

Unit: Count

Description: Describes what the input is to do when selected.

- 0 – As 5V Output
- 1 – Normal Aux 4 input
- 2 – Start SW
- 3 – Seat SW
- 4 – Brake enable SW
- 5 – BRUSH PRESSURE SW
- 6 – EMS SW
- 7 – Cruise Control SW

Parameter #: 152

Screen Name: Aux 4 in switch type

Range: 0 – 5

Unit: Count

Description: Describes the level of input the switch can select. The controller inputs can be selected in 3 typical states: High (Batt+), Mid (float or Open switch), Low (0 or Batt-).

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 153

Screen Name: Aux 5 Input Function

Range: 0 – 10

Unit: Count

Description: Describes what the input is to do when selected (IN14).

- 0 – Not used
- 1 – Normal Aux 5 input
- 2 – Start SW
- 3 – Operator presence SW
- 4 – Brake enable SW
- 5 – BRUSH PRESSURE SW
- 6 – EMS SW
- 7 – Cruise Control SW
- 8 – Mechanical Braker SW
- 9 – Beeper Switch
- 10 – Batt Charge Switch

Parameter #: 154

Screen Name: Aux 5 in switch type

Range: 0 – 5

Unit: Count

Description: Describes the level of input the switch can select. The controller inputs can be selected in 3 typical states: High (Batt+), Mid (float or Open switch), Low (0 or Batt-).

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 155

Screen Name: Valve in Function

Range: 0 – 3

Unit: Count

Description: Valve switch input selection function.

- 0 – Not used
- 1 – Normal valve in
- 2 – Brush load/unload
- 3 – Squeegee Down Limit SW

Parameter #: 156

Screen Name: Valve In Type

Range: 0 – 5

Unit: Count

Description: Valve input switch type - Switch operation.

- 0 – Two state (Normally, open-low Effective/low-RVS)
- 1 – Two state (Normally, open-High Effective/High-RVS)
- 2 – Two state (Normally, closed-Low Effective/Low-FWD)
- 3 – Two state (Normally, closed-High Effective/High-FWD)
- 4 – Three state used in direction SW (Low is reverse)
- 5 – Three state used in direction SW (High is reverse)

Parameter #: 157

Screen Name: Brake Enable Used

Range: 0 – 2

Unit: On/Off

Description: E-Brake Used – a.k.a., Parking Brake.

- 0 – Not Used
- 1 – Yes, The Bypass Brake Switch input is connected, must program selected input to function 4.
- 2 – No, There is no bypass brake switch connected to the controller.

Parameter #: 158

Screen Name: Max Brake Delay

Range: 30 – 255

Unit: 10ms

Description: Max delay time to close brake. When vehicle stops or is very close to stopping the brake is applied. A value of 30 means 30 x 10ms controller timing = 0.30 seconds.

Parameter #: 159

Screen Name: Aux 1 Output Func.

Range: 0 – 12

Unit: Count

Description: S Auxiliary 1 Output function.

0 – Not used

1 – Controlled by Auxiliary 1 input (AUX1_BUF, must program Aux1 input function to 1).

2 – Controlled by Auxiliary 2 input (AUX2_BUF, must program Aux2 input function to 1).

3 – Controlled by direction (Forward is On, Reverse is Off, Neutral is Off).

4 – Controlled by direction (Forward is On, Reverse is Off, Neutral is Off).

5 – Controlled by direction (Forward is On, Reverse is Off, Neutral is Off).

6 – As clean water empty led indicator.

7 – Controlled by communication (Can Command).

8 – As external status led.

9 – Used by specified customer, (Value2).

10 – As beeper controlled by beeper switch input (BEEPER_BUF).

(To be added.)

Parameter #: 160

Screen Name: Aux1 Off delay

Range: 0 – 10

Unit: Sec

Description: Delay time before Auxiliary 1 output is turned OFF.

Parameter #: 161

Screen Name: Aux1 Output Voltage

Range: 0 – 45

Unit: Count

Description: Auxiliary 1 output voltage.

0 – 0v

1 ~ 44 -> 5V ~ 48V

45 – All voltage pull in.

Parameter #: 162

Screen Name: Aux 2 Output Func.

Range: 0 – 9

Unit: Count

Description: Auxiliary 2 Output function.

0 – Not used.

1 – Controlled by Auxiliary 1 input (AUX1_BUF, must program Aux1 input function to 1).

2 – Controlled by Auxiliary 2 input (AUX2_BUF, must program Aux2 input function to 1).

3 – Controlled by direction (Forward is ON, Reverse is OFF, Neutral is OFF).

4 – Controlled by direction (Forward is ON, Reverse is OFF, Neutral is OFF).

5 – Controlled by direction (Forward is ON, Reverse is OFF, Neutral is OFF).

6 – As dirty water full led indicator.

- 7 – Controlled by communication (Can Command).
- 8 – As water pump (working together with brush).
- 9 – As beeper controlled by beeper switch input (BEEPER_BUF).

Parameter #: 163

Screen Name: Aux2 Off delay

Range: 0 – 10

Unit: Count

Description: Delay time before Auxiliary 2 out is closed.

Parameter #: 164

Screen Name: Aux2 Output Voltage

Range: 0 – 45

Unit: Count

Description: Auxiliary 2 output voltage.

0 – 0v

1 ~ 44 -> 5V ~ 48V

45 – All voltage pull in

Parameter #: 165

Screen Name: Brake Output Func.

Range: 0 – 7

Unit: Count

Description: Brake Output function (P1).

0 – Not used

1 – Brake

2 – by Aux3

3 – On/Off

4 – Off/On

5 – On/On

6 – Status LED

7 – By panel

Parameter #: 166

Screen Name: Brake Output Voltage

Range: 0 – 45

Unit: Count

Description: Brake output voltage.

0 – 0v

1 ~ 44 -> 5V ~ 48V

45 – All voltage pull in

Parameter #: 167

Screen Name: Alarm Output Function

Range: 0 – 12

Unit: Count

Description: Alarm Output function.

- 0 – Not used
- 1 – By Aux1
- 2 – By Aux2
- 3 – By Aux3
- 4 – By direction (On/Off)
- 5 – By direction (Off/On)
- 6 – By direction (On/On)
- 7 – By panel
- 8 – As External LED
- 9 – As External Relay
- 10 – Beeper by beeper switch
- 11 – Beeper Plus reverse alarm
- 12 – All alarms

Parameter #: 168

Screen Name: Alarm output Voltage

Range: 0 – 45

Unit: Count

Description: Alarm Output Voltage.

- 0 – 0v
- 1 ~ 44 -> 5V ~ 48V
- 45 – All voltage pull in

Parameter #: 169

Screen Name: Alarm Trig. By Accel

Range: 0 – 1

Unit: Count

Description: If alarm output is enabled by Accelerator.

- 0 – No
- 1 – Yes

Parameter #: 170

Screen Name: Valve Out Function

Range: 0 – 3

Unit: Count

Description: Valve Output Function.

- 0 – Not used
- 1 – By valve in
- 2 – By brush
- 3 – By panel

Parameter #: 171

Screen Name: Valve Output Voltage

Range: 0 – 45

Unit: Count

Description: Valve Output Voltage.

- 0 – 0v
- 1 ~ 44 -> 5V ~ 48V
- 1 – All voltage pull in

Parameter #: 172

Screen Name: Valve Off by RVS

Range: 0 – 1

Unit: Count

Description: This indicates whether the valve is disabled when the direction is reverse.

- 0 – No
- 1 – Yes

Parameter #: 173

Screen Name: Status function

Range: 0 – 3

Unit: Count

Description: Status Output Function.

- 0 – Battery indicator
- 1 – External LED connected to Ground
- 2 – External LED connected to battery

Parameter #: 174

Screen Name: Fresh Water Empty T

Range: 0 – 200

Unit: 0.1 Sec

Description: Clean Water empty judgment time. This is the delay time for water level fluctuation during movement.

Parameter #: 175

Screen Name: Dirty Water Full T

Range: 0 – 200

Unit: 0.1 Sec

Description: Dirty Water Full judgment time. This is the delay time for water level fluctuations during movement.

Parameter #: 176

Screen Name: Valve off-clean empty

Range: 0 – 1

Unit: Count

Description: This indicates whether the valve off in clean empty.

Parameter #: 177

Screen Name: Valve off-dirty full

Range: 0 – 1

Unit: Count

Description: This indicates whether the valve is disabled when dirty water is full.

Parameter #: 178

Screen Name: AUX2 LVL1 on percent

Range: 1 – 100

Unit: %

Description: AUX2 LVL-1 PERCENT.

Parameter #: 179

Screen Name: AUX2 LVL2 on percent

Range: 1 – 100

Unit: %

Description: AUX2 LVL-2 PERCENT.

Parameter #: 180

Screen Name: AUX2 LVL3 on percent

Range: 1 – 100

Unit: %

Description: AUX2 LVL-3 PERCENT

Parameter #: 181

Screen Name: AUX2 LVL4 on percent

Range: 1 – 100

Unit: %

Description: AUX2 LVL-4 PERCENT

Parameter #: 182
Screen Name: AUX2 LVL5 on percent
Range: 1 – 100
Unit: %
Description: AUX2 LVL-5 PERCENT.

Parameter #: 183
Screen Name: AUX2 On time
Range: 1 – 10
Unit: Sec
Description: AUX2 BASE PERIOD.

Parameter #: 184
Screen Name: AUX3 LVL1 on percent
Range: 1 – 100
Unit: %
Description: AUX3 LVL-1 PERCENT.

Parameter #: 185
Screen Name: AUX3 LVL2 on percent
Range: 1 – 100
Unit: %
Description: AUX3 LVL-2 PERCENT.

Parameter #: 186
Screen Name: AUX3 LVL3 on percent
Range: 1 – 100
Unit: %
Description: AUX3 LVL-3 PERCENT.

Parameter #: 187
Screen Name: AUX3 LVL4 on percent
Range: 1 – 100
Unit: %
Description: AUX3 LVL-4 PERCENT.

Parameter #: 188
Screen Name: AUX3 On time
Range: 1 – 60
Unit: Sec
Description: AUX3 BASE PERIOD.

Parameter #: 189

Screen Name: Aux1 output full voltage pull in

Range: 0 – 1

Unit: Count

Description: AUX1 100ms full voltage output during startup.

0 – Disable

1 – Enable

Parameter #: 190

Screen Name: Aux2 output full voltage pull in

Range: 0 – 1

Unit: Count

Description: AUX2 100ms full voltage output during startup.

0 – Disable

1 – Enable

Parameter #: 191

Screen Name: Aux3 output full voltage pull in

Range: 0 – 1

Unit: Count

Description: AUX3 100ms full voltage output during startup.

0 – Disable

1 – Enable

Parameter #: 192

Screen Name: Aux4 output full voltage pull in

Range: 0 – 1

Unit: Count

Description: AUX4 100ms full voltage output during startup.

0 – Disable

1 – Enable

Parameter #: 193

Screen Name: Park brake output full voltage pull in

Range: 0 – 1

Unit: Count

Description: Park brake 100ms full voltage output during start up.

0 – Disable

1 – Enable

Parameter #: 194

Screen Name: ES_time_limit

Range: 0 – 255

Unit: Hour

Description: This describes the maximum trial time.

Parameter #: 195

Screen Name: ES_used_time

Range: 0 – 255

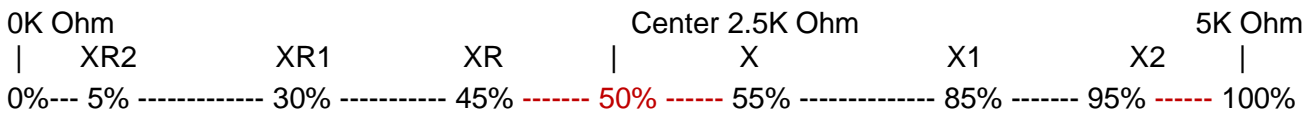
Unit: Hour

Description: This describes the amount of trial time used.

Note 1 – Controller Parameters

Examples of Throttle Pot Input Shaping

Typical Wig Wag Throttle



Red is added for dead band.

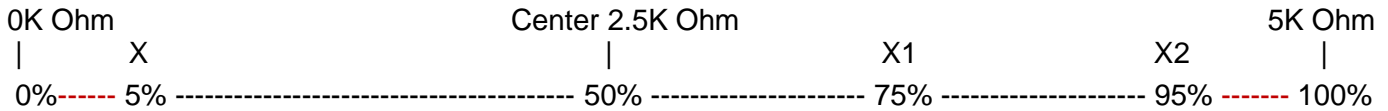
2.5 – 5K Center Forward

ACCEL X VALUE	55 %
ACCEL X1 VALUE	85 %
ACCEL X2 VALUE	95 %
ACCEL Y1 VALUE	50 %

2.5 – 0K Center Reverse

ACCEL XR VALUE	45 %
ACCEL XR1 VALUE	15 %
ACCEL XR2 VALUE	5 %
ACCEL YR1 VALUE	50 %

Linear Type Throttle



Red is added for dead band.

0 – 5K Forward

ACCEL X VALUE	5 %
ACCEL X1 VALUE	75 %
ACCEL X2 VALUE	95 %
ACCEL Y1 VALUE	50 %

Center Reverse

ACCEL XR VALUE	Any %
ACCEL XR1 VALUE	Any %
ACCEL XR2 VALUE	Any %
ACCEL YR1 VALUE	Any %

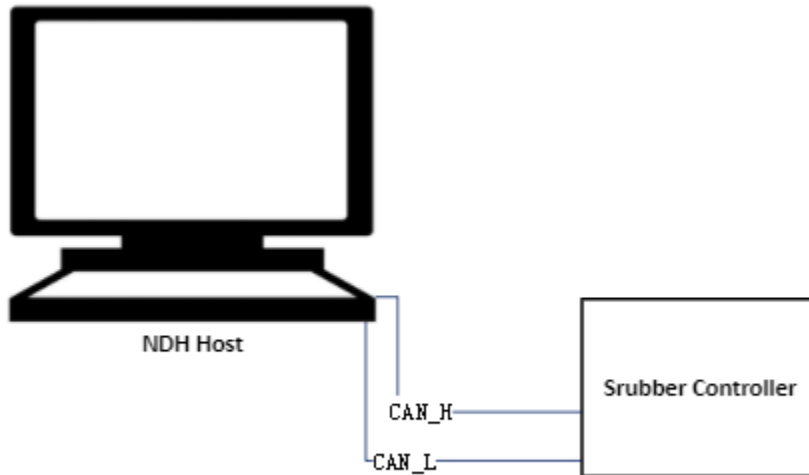
These values are used to calculate the slope of the line segment used for the throttle. Depending on where the throttle (pot) input value is located, either Slop A or Slop B is selected. Shape the throttle response by adjusting Y1 and X1. Give the Start and Stop (dead band) with X and X2. The calculations are as follows:

$$\text{Slop A} = ((\text{Pot}-x)*Y1\%) / (x1-x)$$

$$\text{Slop B} = (Y1\% + ((a-x1)*(Max Speed - Y1\%))/(x2-x1))$$

Appendix C: Fault Diagnostic System

This section provides field technicians with recommendations for accurately diagnosing and troubleshooting certain problems experienced by the controller. The picture below illustrates that basic interface between the NDS Host and the scrubber controller through CAN communication. Contact Nidec Drive Systems for more information regarding interface requirements.

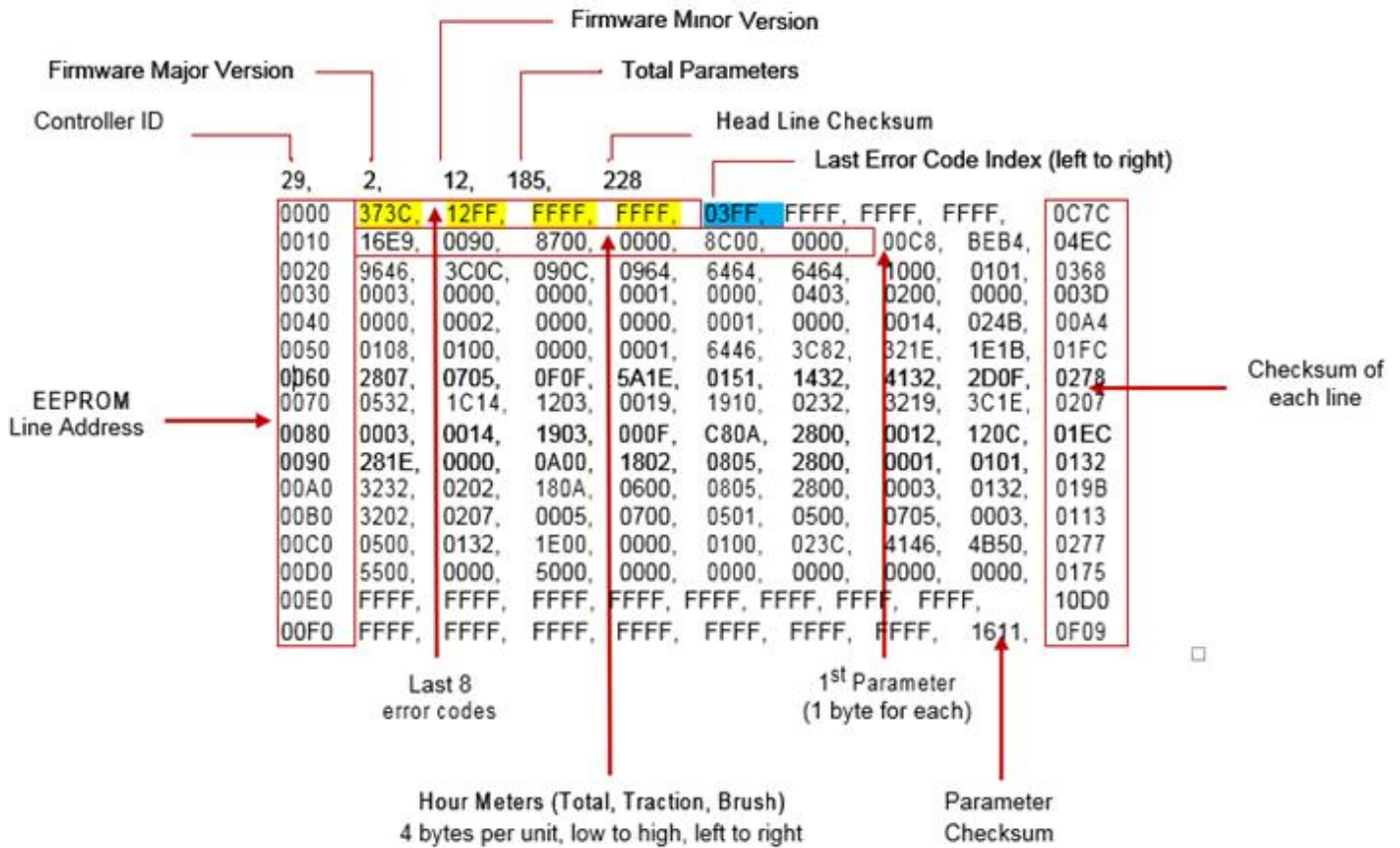


NDS Host Interface

Through the NDS Host interface, the controller can download data stored in the EEPROM and save it in a **.STU** file format. The error code structure uses an 8-location circular buffer to hold error code history. Below is an overview of the index references. The section in yellow is the 8-location error code buffer. Each error code is 2 digits in length. The error code locations count is 1 to 8 beginning from the left. The section in blue is the error code index. Here is an example:

- Error Location #1 – 37
- Error Location #2 – 3C
- Error Location #3 – 12
- Error Location #4 – FF (represents a blank error code location)
- Error Location #5 – FF (represents a blank error code location)
- Error Location #6 – FF (represents a blank error code location)
- Error Location #7 – FF (represents a blank error code location)
- Error Location #8 – FF (represents a blank error code location)

In this example, the Error Code Index is 03.



Based on an **Error Code Index** of **03**, you would move to error Location #3. This error code would be the latest which, in this case, corresponds to **Error Code 12**, found in the **Error Code Table** in the following section, and abbreviated here.

Error Code	Description	Detailed Description	Failure Effect	Possible Cause
0x12	EEPROM_PARAM ETER_FAULT	This fault is logged when internal memory of a scrubber controller reports malfunction.	All functions except Status Out are disabled.	<ol style="list-style-type: none"> 1. The controller parameter setting is out of range. 2. The Controller problem (EEPROM fault).

You then loop backwards to the left for the next most recent (3C error). In this example, Error 37 was the first to occur. There are only 3 errors in the buffer, since all other locations are FF. Had the other locations been values other than FF, you would have looped from **Location 1** to **Location 8** to continue reading the error code history.

Once the Error Code Index reaches 8, i.e., on the 9th error, the Index is reset to 1 and the 9th error is written into **Location 1**, thus forming a circular buffer. If the last error code is the same as the current error code, the error code is not recorded.

Fault Code Table

When the controller software detects an error condition, it shuts down the operation of the controller and provides a visual indication of the error code via the on-board LED display, if equipped. Error codes currently active in the software are listed below. Correction of the fault and a key switch cycling are required to regain safe machine operation after detection of a fault.

Error Code	Name of Fault	Detailed Description	Failure Effect	Open Relays	Recover by Key Switch	Possible Cause	Notes
0x12U	EEPROM_PARAMETE R_FAULT	This fault is logged when internal memory of a scrubber controller reports a malfunction due to a CRC fault ,or out of range configuration.	All functions except Status Out are disabled.	Yes	Yes	1. Controller parameter setting is out of range. 2. Controller Problem (EEPROM CRC fault).	
0x18U	BAT_PUMP_TO_HIGH _FAULT	This fault occurs when battery power is disconnected before turning off the traction motor.	All functions except Status Out are disabled.	Yes	Yes		
0x1AU	LOW_BATTERY_PROT ECT_FAULT	This fault indicates that system battery voltage has been low for longer than the predefined time threshold.	All functions except Status Out are disabled.	Yes	Yes	1. Battery voltage is less than 18V. 2. Parameter "Battery Voltage" is set to 1, but the actual battery is 24V. 3. Controller Hardware fault.	
0x21U	LOW_BATTERY_CHAR GE_FAULT	This fault indicates that the controller detected a sudden drop in battery voltage.	All functions except Status Out are disabled.	Yes	Yes		
0xA2U	HIGH_BATTERY_PRO TECT_FAULT	This fault indicates that system battery voltage has been out of range on the higher side for more than the predefined time threshold.	All functions except Status Out are disabled.	Yes	Yes	1. Battery voltage is >45V. 2. Parameter "Battery Voltage" is set to 0, but the actual battery is 36V. 3. Controller hardware fault.	
0x23U	MCU_THERMAL_PRO TECT_FAULT	This fault indicates that a microcontroller inside the controller is outside of the threshold for high temperature.	All functions except Status Out are disabled.	Yes	Yes	1. The controller is over temperature.	
0x83U	MOS_THERMAL_PRO TECT_FAULT	This fault indicates that the power switching MOSFET is outside of threshold for high temperature.	All functions except Status Out are disabled.	Yes	Yes	1. Longer operation in high ambient temperature.	
0x26U	PRECHARGE_FAULT	This fault indicates that the pre-charge process failed before starting the controller.	All functions except Status Out are disabled.	Yes	Yes	1. Wiring problem. 2. Controller Hardware fault.	
0x2DU	BRUSH_NULL_CURRE NT_FAULT	This fault indicates a brush null current fault.	All functions except Status Out are disabled.	Yes	Yes	1. Controller firmware fault. 2. Controller hardware fault.	

Error Code	Name of Fault	Detailed Description	Failure Effect	Open Relays	Recover by Key Switch	Possible Cause	Notes
0x2EU	VACUUM_NULL_CURRENT_FAULT	This fault indicates a vacuum null current fault.	All functions except Status Out are disabled.	Yes	Yes	1. Controller firmware fault. 2. Controller hardware fault.	
0x2FU	SQUEEGEE_NULL_CURRENT_FAULT	This fault indicates a squeegee null current fault.	All functions except Status Out are disabled.	Yes	Yes	1. Controller firmware fault. 2. Controller hardware fault.	
0x3FU	BRU_DECK_NULL_CURRENT_FAULT	This fault indicates a brush deck null current fault.	Brush Deck output is disabled.	No	Yes	1. Controller firmware fault. 2. Controller hardware fault.	Traction speed is lowered.
0x31U	BRU_ADJ_TIMEOUT_FAULT	This fault indicates a brush adjustment timeout.	All functions except Status Out are disabled.	Yes	Yes	1. This fault indicates the brush pressure output has detected high current at stop condition.	
0x32U	CONTACTOR_WELDED_FAULT	This fault indicates contactor short circuit.	All functions except Status Out are disabled.	Yes	Yes	Controller hardware fault	
0x33U	CONTACTOR_DIDNT_CLOSE_FAULT	This fault indicates that the contactor did not close.	All functions except Status Out are disabled.	Yes	Yes	Controller hardware fault	
0x37U	ACCELERATOR_FAULT	This fault indicates an accelerator fault.	All functions except Status Out are disabled.	Yes	Yes	1. Accelerator PWR wire is broken (for potentiometer accelerator). 2. Accelerator GND wire is broken (for potentiometer accelerator). 3. Accelerator Signal wire is broken (for potentiometer accelerator). 4. Actual accelerator resistance is mismatched with set resistance value (for potentiometer accelerator). 5. Hall Accelerator output is more than 5V.	
0x6AU	VALUE_OVER_CURRENT_FAULT	This fault indicates a valve over current fault.	Valve out is disabled.	Yes	Yes	1. Valve output is over current. 2. Controller hardware fault.	

Error Code	Name of Fault	Detailed Description	Failure Effect	Open Relays	Recover by Key Switch	Possible Cause	Notes
0X3BU	ALARM_OVER_CURRENT_FAULT	This fault indicates an alarm over current fault.	Alarm is disabled.	Yes	Yes	1. Alarm output is over current. 2. Controller hardware fault.	
0X3CU	AUX1_OVER_CURRENT_FAULT	This fault indicates an AUX1 over current fault.	Aux1 out is disabled.	Yes	No	1. Aux1 output is over current. 2. Controller hardware fault.	
0X3DU	AUX2_OVER_CURRENT_FAULT	This fault indicates an AUX2 over current fault.	Aux2 out is disabled.	Yes	Yes	1. Aux1 output is over current. 2. Controller hardware fault.	
0X3AU	BRAKE_OVER_CURRENT_FAULT	This fault indicates a brake over current fault.	Traction and brake are disabled.	Yes	Yes	1. Brake output is over current. 2. Controller hardware fault.	
0x42U	TRACTION_STALLED_FAULT	This fault indicates that the traction current is over the normal current limit.	All functions except Status Out are disabled.	Yes	No	1. Traction motor is stalled. 2. The Traction Limit parameter is set too low.	
0x58U	REGEN_CUR_EXCEED_FAULT	This fault indicates that the traction regen current is over the protection limit.	All functions except Status Out are disabled.	Yes	TBD		
0x59U	LEFT_DRAIN_FAULT	This fault indicates the detection of unusual voltage in the traction left bridge MOSFET.	All functions except Status Out are disabled.	Yes	No		
0x5BU	RIGHT_DRAIN_FAULT	This fault indicates the detection of unusual voltage in the traction right bridge MOSFET.	All functions except Status Out are disabled.	Yes	No		
0x62U	SUPPLY_12V_OUT_OF_RANGE_FAULT	The 12V power supply is out of range.	All functions except Status Out are disabled.	Yes	No	Controller hardware fault.	
0x71U	TRIAL_TIME_OUT_FAULT	-	TBD	TBD	TBD	TBD	
0x77U	BRUSH_STALLED_FAULT	This fault indicates a brush motor stall fault.	All functions except Status Out are disabled.	Yes	No	1. Brush motor is stalled. 2. Parameter "Brush Current Limit" is set too low.	
0x78U	VACUUM_STALLED_FAULT	This fault indicates a vacuum motor stall fault.	The vacuum function is disabled.	Yes	No	1. Vacuum motor is stalled. 2. Parameter "Brush Current Limit" is set too low.	
0x74U	SQUEE_STALLED_FAULT	This fault indicates a squeegee stall fault.	All functions except Status Out are disabled.	Yes	No	1. Squeegee motor is stalled. 2. Parameter "Squee Current Limit" is set too low.	
0x75U	BRU_DECK_STALLED_FAULT	This fault indicates a brush deck motor stall fault.	The Brush Deck function is disabled.	No	No	1. Brush deck motor is stalled. 2. Parameter "Brush Deck Current Limit" is set too low.	Traction speed is lowered.

Error Code	Name of Fault	Detailed Description	Failure Effect	Open Relays	Recover by Key Switch	Possible Cause	Notes
0x7EU	TRA_LEFT_LOW_FET_SHORT_FAULT	This fault indicates a traction bridge bottom-left MOSFET short circuit.	All functions except Status Out are disabled.	Yes	No	Controller hardware fault.	
0x8EU	TRA_LEFT_HIGH_FET_SHORT_FAULT	This fault indicates a traction bridge upper-left MOSFET short circuit.	All functions except Status Out are disabled.	Yes	No	Controller hardware fault.	
0x9AU	TRA_RIGHT_LOW_FET_SHORT_FAULT	This fault indicates a traction bridge bottom-right MOSFET short circuit.	All functions except Status Out are disabled.	Yes	No	Controller hardware fault.	
0x9BU	TRA_RIGHT_HIGH_FET_SHORT_FAULT	This fault indicates a traction bridge upper-right MOSFET short circuit.	All functions except Status Out are disabled.	Yes	No	Controller hardware fault.	
0x9CU	BRU_LOW_FET_SHORT_FAULT	This fault indicates a brush bridge below MOSFET short circuit.	All functions except Status Out are disabled.	Yes	No	Controller hardware fault.	
0x9DU	VACUUM_LOW_FET_SHORT_FAULT	This fault indicates a vacuum bridge below MOSFET short circuit.	All functions except Status Out are disabled.	Yes	No	Vacuum motor is short circuited.	
0x9EU	BRU_DECK_ACTR_SW1_FAULT	This fault indicates a brush deck actuator switch error. (Customer specific)	The Brush Deck function is disabled.	No	No		Traction speed is lowered.
0x9FU	BRU_DECK_ACTR_SW2_FAULT	This fault indicates a brush deck actuator switch error. (Customer specific)	The Brush Deck function is disabled.	No	No		Traction speed is lowered.
0xA3U	UART_CRC_FAULT	This fault indicates a UART CRC calculation fault.	All functions except Status Out are disabled.	Yes	Yes		
0xA1U	UART_COMM_FAULT	This fault indicates a UART offline fault.	All functions except Status Out are disabled.	Yes	No		
0xA4U	UART_REDUNDANT_BIT_FAULT	This fault indicates a UART redundant control bit fault.	All functions except Status Out are disabled.	Yes	Yes		
0xA5U	MCU_BOOT_FAULT	This fault indicates a MCU boot signal fault.	All functions except Status Out are disabled.	Yes	Yes		
0xB4U	CAN_TRANSMISSION_FAULT	This fault indicates a CAN transmission "active" fault.	All functions except Status Out are disabled.	Yes	Yes		

Error Code	Name of Fault	Detailed Description	Failure Effect	Open Relays	Recover by Key Switch	Possible Cause	Notes
0xB5U	CAN_RECEIVE_FAULT	This fault indicates a CAN receive “active” fault.	All functions except Status Out are disabled.	Yes	Yes		
0xB6U	CAN_BUS_OFF_FAULT	This fault is detected if CAN communication is interrupted due to open or short circuit of CAN wires or internal CAN circuit failures.	All functions except Status Out are disabled.	Yes	Yes		
0xD1U	CAN_BIT_STUFF_FAULT	This fault indicates a CAN bit stuff error.	All functions except Status Out are disabled.	No	Yes		
0xB8U	CAN_CRC_FAULT	This fault indicates a CAN CRC error.	All functions except Status Out are disabled.	Yes	Yes		
0xBDU	CODE_CRC_FAULT	This fault indicates that Flash CRC does not match.	All functions except Status Out are disabled.	Already Open	No		
0xBEU	EEPROM_CRC_FAULT	This fault indicates that the EEPROM parameter CRC does not match.	All functions except Status Out are disabled.	Yes	Yes		
0xBFU	EEPROM_OVERFLOW_FAULT		All functions except Status Out are disabled.	Yes	Yes		
0xB9U	SQUEEGEE_OVER_CURRENT_FAULT	This fault indicates a squeegee output current over hardware design threshold fault.	The Squeegee function is disabled.	Yes	Yes		
0xBAU	SQUEEGEE_OPEN_CIRCUIT_FAULT	This fault indicates a squeegee output open circuit fault.	All functions except Status Out are disabled.	Yes	Yes		
0xD2U	TRACT_DDC_NOT_MATCH_FAULT	This fault indicates that DDC from the primary and secondary processors do not match.	All functions except Status Out are disabled.	No	No		
0xBBU	TRACT_NULL_CURRENT_FAULT	This fault indicates a traction null current fault.	All functions except Status Out are disabled.	Yes	Yes		
0xBCU	BRUSH2_NULL_FAULT	This fault indicates a brush2 null current fault.	All functions except Status Out are disabled.	Yes	Yes		

Error Code	Name of Fault	Detailed Description	Failure Effect	Open Relays	Recover by Key Switch	Possible Cause	Notes
0xB2U	TRACT_OC_FAULT	This fault indicates that traction output current is over the hardware design threshold.	All functions except Status Out are disabled.	Yes	Yes		
0xB3U	TRACT_ADC_WDG_OC_FAULT	This fault indicates that traction output current is over the ADC watchdog threshold.	All functions except Status Out are disabled.	Yes	Yes		
0xC1U	SUPPLY_5V_OUT_OF_RANGE_FAULT	The 5V power supply is out of range.	All functions except Status Out are disabled.	Yes	Yes		
0xC2U	BRUSH_OVER_CURRENT_FAULT	This fault indicates that brush output current is over the hardware design threshold.	All functions except Status Out are disabled.	Yes	Yes		
0xC3U	BRU_DECK_OVER_CURRENT_FAULT	This fault indicates that brush deck output current is over the hardware design threshold.	The Brush Deck function is disabled.	No	Yes		Traction speed is lowered.
0xC4U	VACUUM_OVER_CURRENT_FAULT	This fault indicates that vacuum output current is over the hardware design threshold.	All functions except Status Out are disabled.	Yes	Yes		
0xC5U	VALUE_OPEN_CIRCUIT_FAULT	This fault indicates a valve open circuit fault.	All functions except Status Out are disabled.	Yes	Yes		
0xC6U	ALARM_OPEN_CIRCUIT_FAULT	This fault indicates an alarm open circuit fault.	All functions except Status Out are disabled.	Yes	Yes		
0xC7U	AUX1_OPEN_CIRCUIT_FAULT	This fault indicates an AUX1 open circuit fault.	All functions except Status Out are disabled.	Yes	Yes		
0xC8U	AUX2_OPEN_CIRCUIT_FAULT	This fault indicates an AUX2 open circuit fault.	All functions except Status Out are disabled.	Yes	Yes		
0xC9U	BRAKE_OPEN_CIRCUIT_FAULT	This fault indicates a brake open circuit fault.	All functions except Status Out are disabled.	Yes	Yes		
0xCAU	CONTACTOR_OVER_CURRENT_FAULT	This fault indicates a contactor line coil over current fault.	All functions except Status Out are disabled.	Yes	Yes		

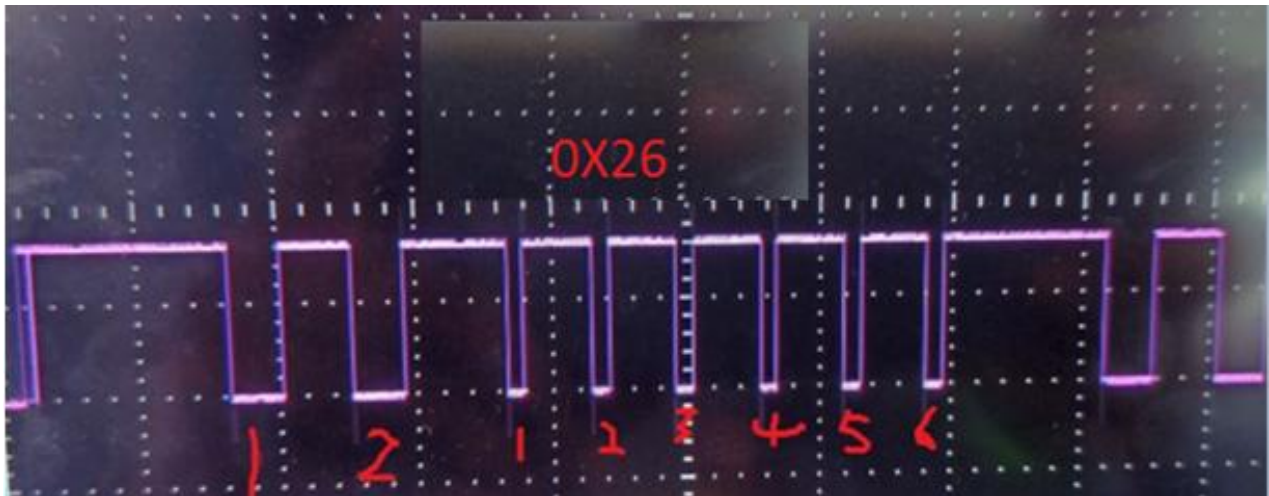
Error Code	Name of Fault	Detailed Description	Failure Effect	Open Relays	Recover by Key Switch	Possible Cause	Notes
0xCBU	SUPPLY_3V3_LOW_FAULT	This fault indicates an MCU 3.3V voltage low fault.	All functions except Status Out are disabled.	Yes	Yes		
0xCCU	ERROR_FAULT	This fault indicates a redundant variable mismatch fault.	All functions except Status Out are disabled.	Yes	Yes		
0x34U	CONTACTOR_CKT_FAULT	This fault indicates a switching MOSEFT in the contactor control circuit has malfunctioned.	All functions except Status Out are disabled.	Yes	No		
0x19U	BRU_DECK_OPEN_CIRCUIT_FAULT	This fault indicates brush deck open circuit is detected.	The Brush Deck function is disabled.	No	Yes		Traction speed is lowered.
0x35U	WWDG_REPETITION_FAULT	This fault indicates that the Watchdog reset more than 3 times during one key cycle.	All functions except Status Out are disabled.	Yes	Yes		
0x36U	HAL_FAULT	This fault indicates that the hardware abstraction layer has a configuration, initialization, or access malfunction.	All functions except Status Out are disabled.	Yes	Yes		

LED Diagnosis Method

The scrubber controller has an onboard LED which is used to display the power status and the latest fault code (if any). At power up, if the battery voltage is within range, the LED color turns green. If an error occurs, the LED color turns red and starts blinking the fault code.

Note: The fault code calculation shown below is for purposes of illustration only. Since the LED is protected by a top cover, opening the cover to see the LED-based fault code must be done only after consulting with a Nidec Service Engineer.

Example: Once a fault is logged, the onboard LED starts blinking the fault code in a pattern that is specific to the fault code. In the example below, there would be 2 long pulses and 6 short pulses. The fault code is 0x26, which is PRECHARGE_FAULT, indicating that the pre-charge process failed prior to starting the controller. After correcting the fault condition and cycling the key, the blinking pattern stops.



Note: This diagnosis has been carried out using DSO when LED terminals are accessible. The user can also read the LED pattern by observing the long and short pulses to understanding the equivalent fault code.

Warranty Information

Limited Warranty

Nidec Motor Corporation (d/b/a Imperial Electric) ("IE") extends the following LIMITED WARRANTY to the purchaser and to its customers (collectively referred to as the "Purchaser") of the enclosed battery charger and components (collectively referred to as the "Goods"): the Goods are free from defects in materials and workmanship under normal use, service and maintenance FOR A PERIOD OF 12 MONTHS FROM THE DATE OF ORIGINAL PURCHASE FROM IE OR THE IE DEALER/RETAILER, NOT TO EXCEED 30 MONTHS FROM THE DATE OF MANUFACTURE BY IE. THE FOREGOING WARRANTY IS THE SOLE AND EXCLUSIVE WARRANTY GIVEN AND ARE IN LIEU OF AND EXCLUDE ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WHETHER OR NOT THE PURPOSE OR USE HAS BEEN DISCLOSED TO SELLER IN SPECIFICATIONS, DRAWINGS OR OTHERWISE, AND WHETHER OR NOT SELLER'S PRODUCTS ARE SPECIFICALLY DESIGNED AND/OR MANUFACTURED BY SELLER FOR BUYER'S USE OR PURPOSE.

This warranty does not extend to any losses or damages due to misuse, accident, abuse, neglect, normal wear and tear, negligence (other than Seller's), unauthorized modification or alteration, use beyond rated capacity, unsuitable power sources or environmental conditions, improper installation, repair, handling, maintenance or application or any other cause not the fault of Seller. To the extent that Buyer or its agents has supplied specifications, information, representation of operating conditions or other data to Seller in the selection or design of the Goods and the preparation of Seller's quotation, and in the event that actual operating conditions or other conditions differ from those represented by Buyer, any warranties or other provisions contained herein which are affected by such conditions shall be null and void.

If within thirty (30) days after Purchaser's discovery of any warranty defects within the warranty period, Purchaser notifies IE or the dealer from whom the Goods were purchased in writing, IE shall, at its option and as Purchaser's exclusive remedy, repair or replace or refund the purchase price for that portion of the Goods found by IE to be defective. Failure by Purchaser to give such written notice within the applicable time period shall be deemed an absolute and unconditional waiver of Purchaser's claim for such defects. If the battery charger is damaged in transit, Purchaser should file a claim directly with the carrier.

All costs associated with dismantling, reinstallation and the time and expense of IE's personnel and representatives for site travel and diagnosis under this warranty shall be borne by the Purchaser. Goods repaired or replaced during the warranty period shall be covered by the foregoing warranty for the remainder of the original warranty period or ninety (90) days from the date of shipment, whichever is longer. Purchaser assumes all other responsibility for any loss, damage, or injury to persons or property arising out of, connected with, or resulting from the use of Goods, either alone or in combination with other products/components.

IN NO EVENT, REGARDLESS OF THE FORM OF THE CLAIM OR CAUSE OF ACTION (WHETHER BASED IN CONTRACT, INFRINGEMENT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE), SHALL NIDEC'S LIABILITY TO PURCHASER OR ITS CUSTOMER EXCEED THE PRICE PAID BY PURCHASER FOR THE SPECIFIC BATTERY CHARGER OR OTHER GOODS PROVIDED BY GIVING RISE TO THE CAUSE OF ACTION. IN NO EVENT SHALL NIDEC'S LIABILITY TO PURCHASER OR ITS CUSTOMER EXTEND TO INCLUDE INCIDENTAL CONSEQUENTIAL OR PUNITIVE DAMAGES. WITH RESPECT TO CONSUMER PRODUCTS, SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU.

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The Nidec logo consists of the word "Nidec" in a bold, italicized, green sans-serif font. The letter "N" is significantly larger than the other letters and has a distinctive shape with a small gap at the top.

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