

ProBell® Electrostatic Controller

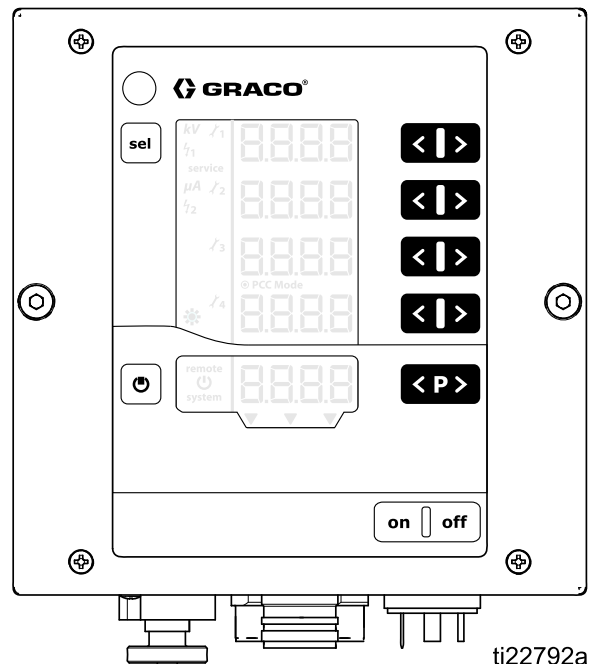
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EN

For controlling a ProBell rotary applicator as part of a paint coating system. For professional use only.
Not approved for use in explosive atmospheres or hazardous locations.



Important Safety Instructions

Read all warnings and instructions in this manual and in your ProBell® Rotary Applicator manual. **Save these instructions.**



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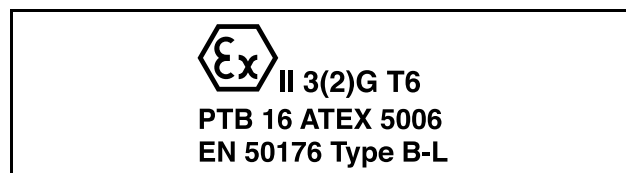
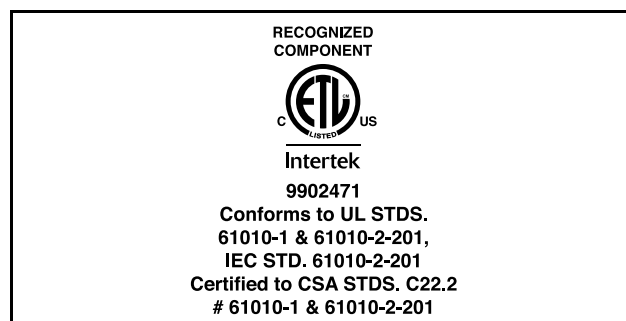
Models

Controller	Controller Series	Description	Maximum Voltage Output at Applicator
24Z098	F	ProBell® Electrostatic Controller, solventborne	100 kV
24Z099	F	ProBell® Electrostatic Controller, waterborne	60 kV

Approved System Components

Specific Electrostatic Controllers, applicator models, and power cables must be used together. Refer to the table below for compatible models.

Model	Electrostatic Controller	Power Supply Cables	Product Type	System Approvals
RxAxx0	24Z098	17J586 17J588 17J589	Solventborne	CE
RxAxx8	24Z099	17J586 17J588 17J589	Waterborne	CE






Related Manuals

Manual No.	Description
334452	ProBell® Rotary Applicator, Instructions/Parts
334626	ProBell® Rotary Applicator, Hollow Wrist, Instructions/Parts
3A3953	ProBell® Speed Controller
3A3954	ProBell® Air Controller
3A3955	ProBell® System Logic Controller
3A4232	ProBell® Cart Systems
3A4346	ProBell® Hose Bundles Kit
3A4384	ProBell® System CGM Installation Kit
3A4738	ProBell® Reflective Speed Sensor Kit
3A4799A	ProBell® Air Filters Kit

Warnings

The following warnings are for the setup, use, grounding, maintenance, and repair of this equipment. The exclamation point symbol alerts you to a general warning and the hazard symbols refer to procedure-specific risks. When these symbols appear in the body of this manual or on warning labels, refer back to these Warnings. Product-specific hazard symbols and warnings not covered in this section may appear throughout the body of this manual where applicable.

 WARNING	
 	<p>ELECTRIC SHOCK HAZARD This equipment must be grounded. Improper grounding, setup, or usage of the system can cause electric shock.</p> <ul style="list-style-type: none">• Turn off and disconnect power at main switch before disconnecting any cables and before servicing or installing equipment.• Connect only to grounded power source.• All electrical wiring must be done by a qualified electrician and comply with all local codes and regulations. <p>For waterborne systems:</p> <ul style="list-style-type: none">• Connect the applicator to a voltage isolation system that will discharge the system voltage when not in use.• All components of the voltage isolation system that are charged to high voltage must be contained within an isolation enclosure that prevents personnel from making contact with the high voltage components before the system voltage is discharged.• Follow the Pressure Relief Procedure, including Voltage Discharge, in your applicator manual when instructed to discharge the voltage; before cleaning, flushing, or servicing the system; before approaching the front of the applicator; and before opening the isolation enclosure for the isolated fluid supply.• Do not enter a high voltage or hazardous location until all high voltage equipment has been discharged.• Do not touch the applicator or enter the spray area during operation. Follow the Pressure Relief Procedure, including Voltage Discharge, in your applicator manual.• Interlock the electrostatics controller with the voltage isolation system to shut off the electrostatics anytime the isolation system enclosure is opened.• Do not splice fluid hoses together. Install only one continuous Graco Waterborne Fluid Hose between the isolated fluid supply and the applicator.



WARNING



FIRE AND EXPLOSION HAZARD

Flammable fumes, such as solvent and paint fumes, in the work area can ignite or explode. Paint or solvent flowing through the system can cause static sparking. To help prevent fire or explosion:



- Electrostatic equipment must be used only by trained, qualified personnel who understand the requirements of this manual.
- Ground all equipment, personnel, object being sprayed, and conductive objects in or close to the spray location. Resistance must not exceed 1 megohm. See **Grounding** instructions.



- Do not use pail liners unless they are conductive and grounded.
- Always use the required arc detection settings and maintain a safe distance of at least 6 inches (152 mm) between the applicator and the workpiece.
- **Stop operation immediately** if static sparking or repeated arc detection errors occur. Do not use equipment until you identify and correct the problem.



- Check applicator resistance and electrical grounding daily.
- Use and clean equipment only in a well ventilated location.
- Always turn off and discharge the electrostatics when flushing, cleaning or servicing equipment.
- Eliminate all ignition sources; such as pilot lights, cigarettes, portable electric lamps, and plastic drop cloths (potential static arc).
- Do not plug or unplug power cords or turn lights on or off when flammable fumes are present.
- Keep the spray area clean at all times. Use non-sparking tools to clean residue from the booth and hangers.
- Keep a working fire extinguisher in the work location.
- Interlock the gun air and fluid supply to prevent operation unless ventilation air flow is above the minimum required value.
- Interlock the Electrostatic Controller and fluid supply with the booth ventilation system to disable operation if the air flow falls below minimum values. Follow your local codes.

For solventborne systems only:

Use only Group IIA or Group D materials.

- Use cleaning solvents with highest possible flash point when flushing or cleaning equipment.
- To clean the exterior of the equipment, cleaning solvents must have a flash point at least 15°C (59°F) above ambient temperature. Non-ignitable fluids are preferred.

For waterborne systems only:

Use conductive waterborne fluids that meet at least one of the following conditions for non-flammability:

- Material does not sustain burning in accordance with the Standard Test Method for Sustained Burning of Liquid Mixtures, ASTM D4206.
- Material is classified as non-ignitable or hard to ignite as defined by EN 50176.



WARNING



EQUIPMENT MISUSE HAZARD

Misuse can cause death or serious injury.



- Always operate in accordance with all information given in the instruction manuals.
- Do not operate the unit when fatigued or under the influence of drugs or alcohol.
- Do not exceed the maximum working pressure or temperature rating of the lowest rated system component. See **Technical Specifications** in all equipment manuals.
- Use fluids and solvents that are compatible with equipment wetted parts. See **Technical Specifications** in all equipment manuals. Read fluid and solvent manufacturer's warnings. For complete information about your material, request the Safety Data Sheet (SDS) from distributor or retailer.
- Turn off all equipment and follow the **Pressure Relief Procedure** when equipment is not in use.
- Check equipment daily. Repair or replace worn or damaged parts immediately with genuine manufacturer's replacement parts only.
- Do not alter or modify equipment. Alterations or modifications may void agency approvals and create safety hazards.
- Make sure all equipment is rated and approved for the environment in which you are using it.
- Use equipment only for its intended purpose. Call your distributor for information.
- Route hoses and cables away from traffic areas, sharp edges, moving parts, and hot surfaces.
- Do not kink or over bend hoses or use hoses to pull equipment.
- Keep children and animals away from work location.
- Comply with all applicable safety regulations.



PERSONAL PROTECTIVE EQUIPMENT

Wear appropriate protective equipment when in the work location to help prevent serious injury, including eye injury, hearing loss, inhalation of toxic fumes, and burns. This protective equipment includes but is not limited to:

- Protective eyewear, and hearing protection.
- Respirators, protective clothing, and gloves as recommended by the fluid and solvent manufacturer.

Introduction

The Electrostatic Controller is designed exclusively for controlling a ProBell rotary applicator as part of a paint coating system.

The controller sends power to the applicator power supply, which increases the voltage to the level set at

the controller. The fluid is charged by the applicator. The charged fluid is attracted to the nearest grounded object, wrapping around and evenly coating all surfaces.

Controller Features and Options

- The full voltage setting is 100 kV for solventborne models and 60 kV for waterborne models.
- The controller can be mounted on the cart or wall mounted. See [Mounting, page 16](#).

The Electrostatic Controller provides the ability to:

- Display and set the voltage and current.
- Create and store spray presets.
- Operate the applicator electrostatics remotely via discrete I/O or Graco CAN.

The controller has three interlocks. These interlocks must be satisfied before the controller will operate. Check and follow all National, State, and Local codes regarding properly interlocking your spray system. Other interlocks will be required. See [Interlocks, page 8](#).

Installation

Interlocks

Interlocks are required to ensure that the system is safe to operate. The controller can use internal or external signals to receive verification that monitored interlock conditions are in a state that is safe for the system to operate.

- **Electrostatic controller and solvent trigger:** Interlock so that solvent will not flow when the electrostatics are on.
- **Electrostatic controller and all doors or openings in the spray area:** Interlock so the electrostatics turn off and are fully discharged before live parts can be reached.
- **Conveyor and paint trigger/electrostatics:** Interlock so the rotary applicator stops spraying and the electrostatics turn off if the conveyor stops moving.
- **Electrostatic controller and ventilation fans:** Interlock so the electrostatics turn off any time the ventilation air flow falls below the minimum required value. Follow local codes.

- **Electrostatic Controller and Fluid Supply:** Interlock so the fluid supply shuts off in the event of a controller fault.
- **Electrostatic controller and fire control system:** Interlock so the electrostatics turn off any time the automatic fire extinguishing system is activated. Check interlock function every 6 months.
- **Electrostatic controller and waterborne isolation system (for waterborne systems):** Interlock so the electrostatics turn off and are fully discharged before live parts can be reached. Check interlock function weekly.

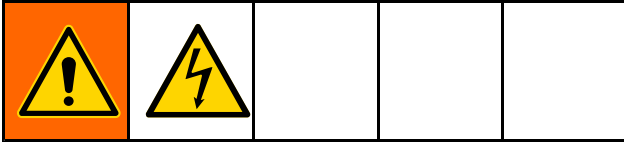
The following table shows how to use the Electrostatic Controller for each interlock. The table also explains how to bypass the interlock if the requirement is being satisfied in another manner.

If other forms of interlock are implemented that preclude the need to use the controller interlocks, the controller interlocks can be disabled.

Table 1 Electrostatic Interlock Information

Interlock	Pin	Description
System Interlock	Input power cord, Pin 3 (wire 3)	<p>Pin 3 on the Input Power Connection requires line voltage to be applied for electrostatics to be active. See Step 2 in Connections, page 19. This pin can be used to connect to safety interlock devices using line power.</p> <p>If not required, bypass the interlock by connecting wire 3 to line voltage on the Input Power cord. The system icon is displayed on the controller screen when the System Interlock is satisfied. See Screen Areas, page 39.</p>
24 VDC Interlock	Discrete I/O cable, pin 19	<p>Pin 19 on the Discrete I/O Cable Connection requires 24 VDC to be applied for electrostatics to be active. This pin can be used to connect to an external device, such as a ventilation interlock signal to the controller. Input signal values are:</p> <p>0 (0 VDC or GND): Interlock not satisfied; electrostatics disabled</p> <p>1 (24 VDC): interlock satisfied; electrostatics activation is not locked by this input.</p> <p>If not required, apply a constant 24 VDC to Pin 19, or see Disable Controller Interlocks, page 10.</p> <p>Symbol A9 on the display screen (see Screen Areas, page 39) will show that this signal is satisfied.</p>
SAFE POSITION Interlock	Discrete I/O cable, pin 18	<p>Pin 18 on the Discrete I/O Cable Connection requires 24 VDC to be applied for electrostatics to be active. Apply only when the applicator is in SAFE POSITION. See Safe Position Mode, page 31. If electrostatics are on, removing 24 VDC from this pin will not deactivate the electrostatics.</p> <p>0 (0 VDC or GND): Interlock not satisfied; If electrostatics are off, electrostatics disabled. If electrostatics are on, no change to electrostatics.</p> <p>1 (24 VDC): Interlock satisfied; electrostatics activation is not locked by this input.</p> <p>If not required, apply a constant 24 VDC to Pin 18, or see Disable Controller Interlocks, page 10.</p> <p>Symbol A10 on the display screen (see Screen Areas, page 39) will show that this signal is satisfied.</p>

Disable Controller Interlocks

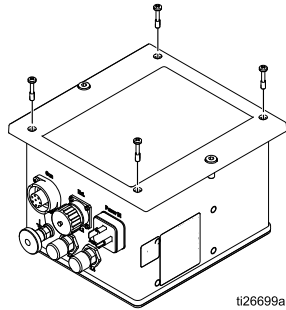


If interlock requirements have been satisfied in your system by means other than the Electrostatic Controller, the controller interlocks can be disabled.

NOTICE

To avoid damaging the circuit boards when servicing the control box, wear Part No. 112190 grounding strap on your wrist. Ground appropriately each time

1. To disable the system interlock, connect wire 3 on the controller input power cord to line voltage. The **system** icon will be lit on the display screen.
2. Remove power from the controller.
3. Remove four screws and take off the access cover.

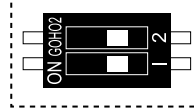
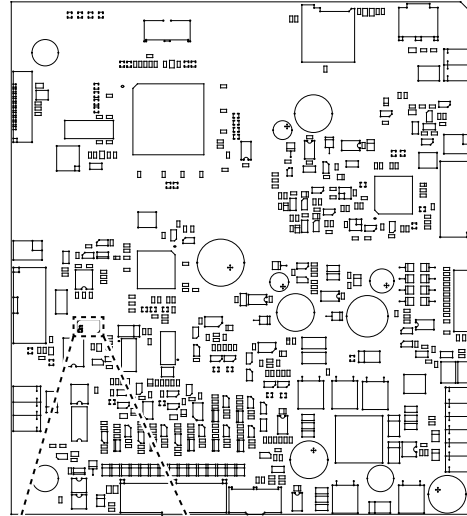


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4. Locate the interlock switches on the main board. Move the switches to the ON position, which means the interlocks are considered satisfied.

Switch 1 is the 24 VDC Interlock (pin 19 on the Discrete I/O cable). Switch 2 is the SAFE POSITION Interlock (Pin 18 on the Discrete I/O cable).

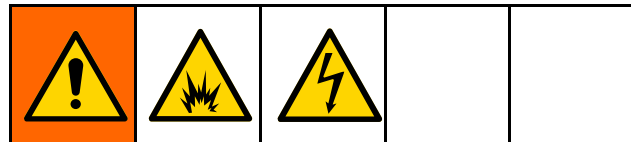
Symbols in A9 and A10 (see [Screen Areas, page 39](#)) on the display screen will show that these signals are satisfied.



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Interlock switches are shown in the OFF position.

Installation Options





Installing and servicing this equipment requires access to parts which may cause fire, explosion, electric shock or other serious injury if work is not performed properly.

- Do not install or service this equipment unless you are trained and qualified.
- Be sure your installation complies with national, state, and local codes for the installation of electrical apparatus in a Class I, Division 1, or a Group II, Zone 1 Hazardous Location.
- Comply with all applicable local, state, and national fire, electrical, and other safety regulations.

Installation details vary widely depending on the system requirements. This section shows three typical installations. They are not actual system designs. For assistance in designing a system to suit your particular needs, contact your Graco distributor.

No Integration

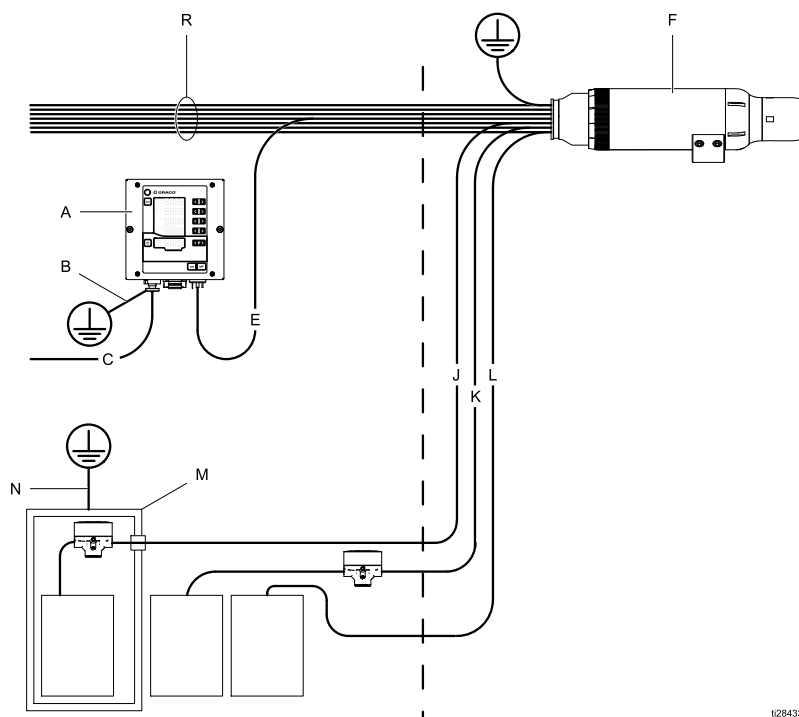
				
<p>To reduce the risk of fire and explosion, the controller (A) must be electrically interlocked with the spray booth ventilation fans to prevent the applicator from operating unless ventilation air flow is above the minimum required value.</p>				

The defining characteristics of a No Integration installation include:

- No integration of the rotary applicator or the Electrostatic Controller.
- Local operation using the Electrostatic Controller interface.
- Interlocks managed independently of the applicator installation.

Non-Hazardous Location

Hazardous Location






KEY:

A	Electrostatic Controller
B	Electrostatic Controller Ground Wire
C	Electrostatic Controller Power Cord
E	Power Supply Cable
F	Rotary Applicator
J	Paint Supply Line
K	Dump Return Line
L	Solvent Supply Line
M	Fluid Supply (isolation equipment needed for waterborne applications only)
N	Fluid Supply Grounding Wire
R	Air Lines

Typical Installation With No Integration

Basic Integration

			
<p>To reduce the risk of fire and explosion, the Electrostatic Controller (A) must be electrically interlocked with the spray booth ventilation fans to prevent the applicator from operating unless ventilation air flow is above the minimum required value.</p>			

The defining characteristics of a Basic Integration installation include:

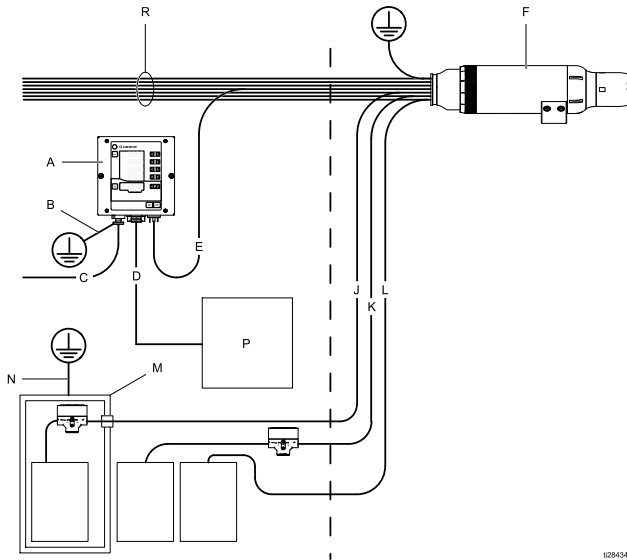
- Integration of basic applicator and controller functions.
- Integration of controller interlocks.
- Local operation of setup and error functions.

This example shows a basic integration that uses 6 of the 19 signals available on the Discrete I/O cable.

- **Preset Select 1 (Pin 1) and Preset Select 2 (Pin 2):** Used to select Presets P000-P003. For example: Select Preset P002 by applying 24V to Pin 2 and Ground or no connection to Pin 1.
- **Remote Enable/Disable (Pin 4):** Enable remote control through the Discrete I/O interface by applying 24V to Pin 4.
- **Electrostatic Enable (Pin 5):** Use a switched voltage source for Pin 5 to activate/trigger the electrostatics.
- **GND (Pins 8, 12, 17):** Used as ground reference for I/O signals.
- **Interlocks:** See [Interlocks, page 8](#), for information on how to set up the required interlocks.

Non-Hazardous Location

Hazardous Location






Typical Installation With Basic Integration

KEY:

A	Electrostatic Controller
B	Electrostatic Controller Ground Wire
C	Electrostatic Controller Power Cord
D	Discrete I/O Cable
E	Power Supply Cable
F	Rotary Applicator
J	Paint Supply Line
K	Dump Return Line
L	Solvent Supply Line
M	Fluid Supply (isolation equipment needed for waterborne applications only)
N	Fluid Supply Grounding Wire
P	Discrete I/O Signals
R	Air Lines

PLC Integration

				
<p>To reduce the risk of fire and explosion, the Electrostatic Controller (A) must be electrically interlocked with the spray booth ventilation fans to prevent the applicator from operating unless ventilation air flow is above the minimum required value.</p>				

The defining characteristics of a PLC (Programmable Logic Controller) Integration installation include PLC integration of all applicator and controller functions.:

See [Discrete I/O, page 21](#), for a complete description of the signals.

KEY:

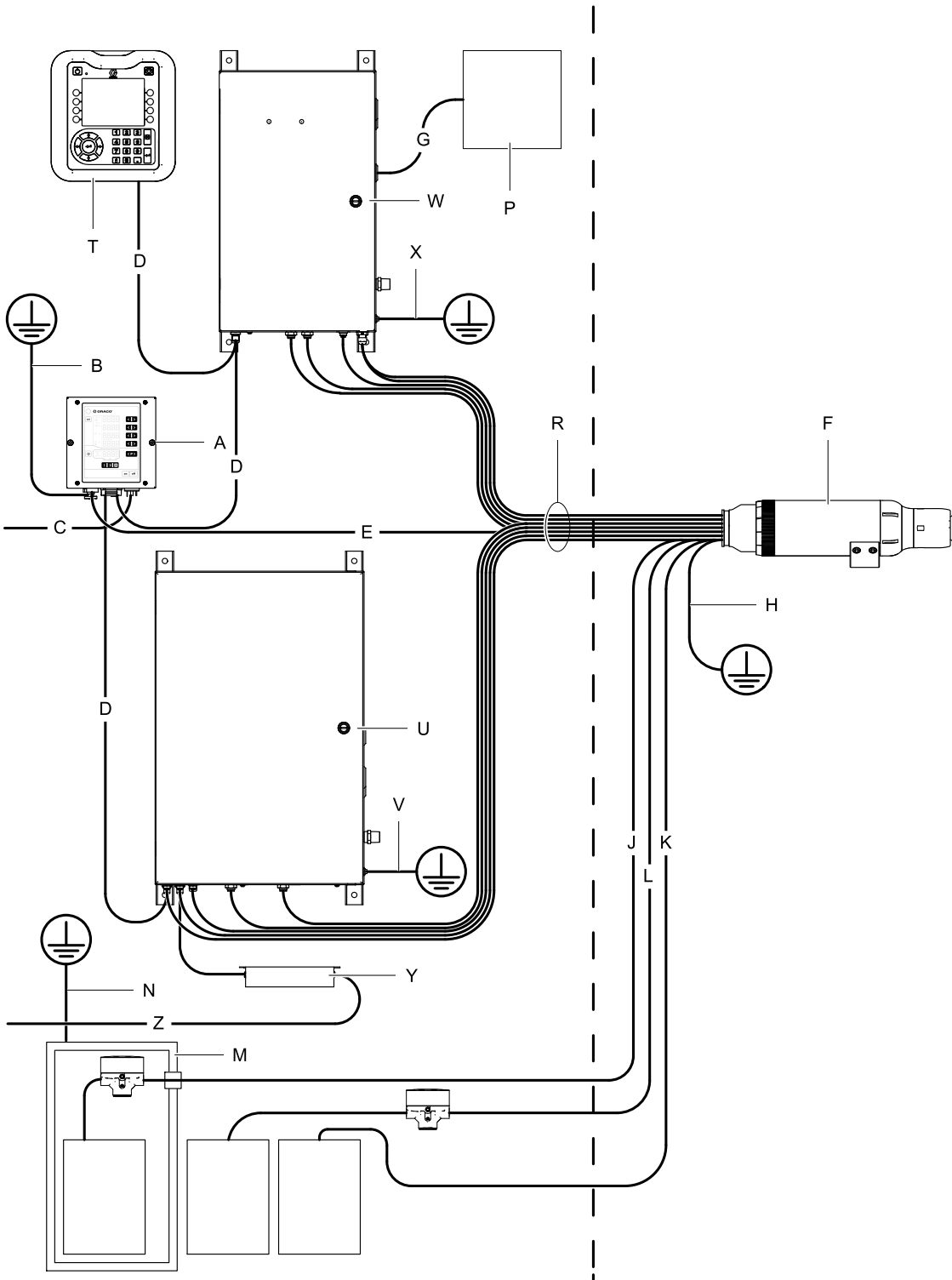
A	Electrostatic Controller
B	Electrostatic Controller Ground Wire
C	Electrostatic Controller Power Cord
D	CAN Cable
E	Power Supply Cable
F	Rotary Applicator
G	PLC Communication Protocol Cable
H	Applicator Grounding Wire
J	Paint Supply Line
K	Dump Return Hose
L	Solvent Supply Line
M	Fluid Supply (isolation equipment needed for waterborne applications only)
N	Fluid Supply Grounding Wire
P	PLC (connected to Gateway inside speed controller box)
R	Air Lines
T	Advanced Display Module (System Logic Controller)
U	Air Controller
V	Air Controller Grounding Wire
W	Speed Controller
X	Speed Controller Grounding Wire
Y	Power Supply
Z	Power Supply Power Cord

Installation

Non-Hazardous Location

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Hazardous Location



Typical Installation With PLC Integration

Pre-Installation Steps

Ventilate the Spray Booth

				
<p>Provide fresh air ventilation to avoid the buildup of flammable or toxic vapors when spraying, flushing, or cleaning the applicator. Do not operate the applicator unless ventilation air flow is above the minimum required value..</p>				



Electrically interlock the Electrostatic Controller (A) with the ventilators to prevent applicator operation unless ventilation air flow is above the minimum required value. Use the 24 VDC Interlock pin on the Discrete I/O cable to connect to the ventilator interlock. Check and follow all National, State, and Local codes regarding air exhaust velocity requirements.

NOTE: High velocity air exhaust will decrease the operating efficiency of the electrostatic system. The minimum allowable air exhaust velocity is 60 ft/minute (19 linear meters/minute).

Install the Rotary Applicator

See the Rotary Applicator Manual (334452 or 334626) for installation instructions.

Interlock the Isolation Enclosure (Waterborne Only)

				
<p>To reduce the risk of electric shock, interlock the Electrostatic Controller with the voltage isolation system to shut off the electrostatics anytime the isolation system enclosure is opened.</p>				

For information about the interlocks and their use, see [Interlocks, page 8](#) .

Mount the Controller

				
To reduce the risk of fire or explosion, do not install equipment approved only for a non-hazardous location in a hazardous location.				

Location

Install the Electrostatic Controller in a non-hazardous location only.

Mounting

The Electrostatic Controller can be mounted on the cart or wall mounted.

Wall Mount (Flat Panel)

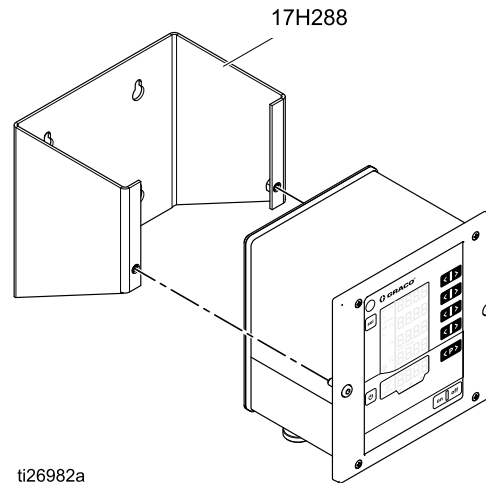
An optional method of mounting the controller is to use a panel with a cutout and mounting holes.

1. See [Dimensions, page 75](#).
2. Determine the mounting location. Ensure that the location will support the mounting panel and the controller.
3. Prepare the panel by cutting out the opening and preparing the mounting holes for the controller:
 - a. If the two controller front panel screws are to be used to attach the controller to the panel, the panel holes will require tapping threads, or providing some other sort of threaded fastener, such as PEM nuts on the panel.
 - b. If an alternative fastener will be used, it may be necessary to back out the two threaded fasteners from the controller front cover so that the mounting hardware can use the existing controller front panel mounting holes.

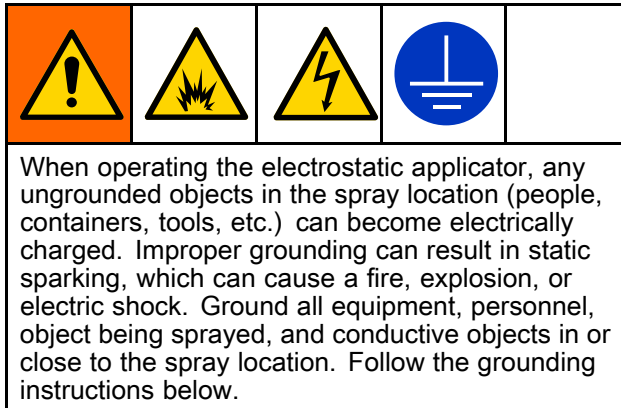
Wall Mount (Mounting Bracket)

An optional wall mount bracket (17H288) is available to mount the controller on any flat wall.

1. See [Dimensions, page 75](#).
2. Determine mounting location. Ensure that the wall is strong enough to support the weight of the mounting bracket and the controller.
3. Position the mounting bracket on the wall and mark mounting holes using the plate of the bracket as a template.
4. Drill holes and attach the mounting bracket to the wall.
5. Attach the controller to the wall mount bracket using two 6 mm screws (provided).



Grounding

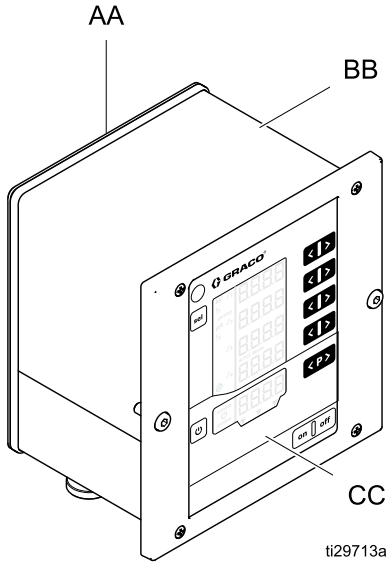


The following are minimum grounding requirements for a basic electrostatic system. Your system may include other equipment or objects which must be grounded. Check your local electrical code for detailed grounding instructions. Your system must be connected to a true earth ground.

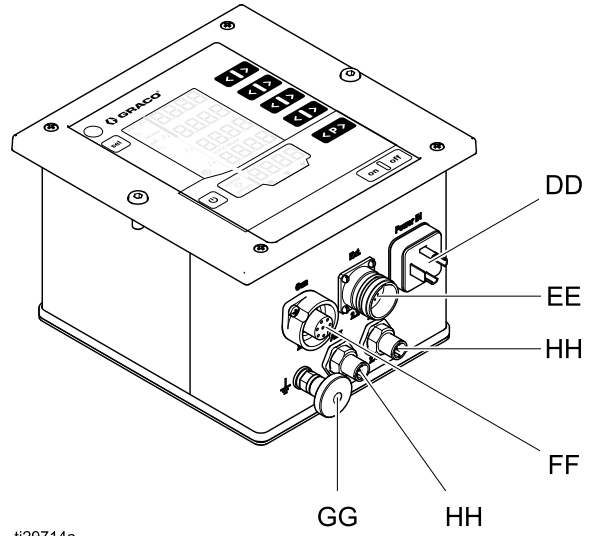
- *Rotary Applicator:* Ground the applicator by connecting the power supply cable to a properly grounded Electrostatic Controller and connecting the ground wire to a true earth ground.
- *Cart:* Use the ground wire and clamp provided to ground the frame to a true earth ground.
- *Air Controller and Speed Controller:* If not mounted on the Cart, use a ground wire and clamp to ground to a true earth ground.
- *Electrostatic Controller:* Use the ground wire and clamp provided to ground the Electrostatic Controller to a true earth ground.
- *Pump:* ground the pump by connecting a ground wire and clamp as described in your separate pump instruction manual.
- *Voltage Isolation System (for waterborne systems):* Follow the grounding procedure in the manufacturer's instructions.
- *Fluid Hose (for waterborne systems only):* The hose is grounded through the conductive layer.
- *Air compressors and hydraulic power supplies:* Ground the equipment according to the manufacturer's recommendations.
- *All air and fluid lines* must be properly grounded.
- *All electrical cables* must be properly grounded.
- *All persons entering the spray area:* Shoes must have conductive soles, such as leather; or personal grounding straps must be worn. Do not wear shoes with non-conductive soles such as rubber or plastic. Gloves and other protective clothing must also be conductive. Resistance must not exceed 100 megohm per EN ISO 20344, EN1149-5.
- *Object being sprayed:* Keep the workpiece hangers clean and grounded at all times. Resistance must not exceed 1 megohm.
- *The floor of the spray area:* The floor must be electrically conductive and grounded. Do not cover the floor with cardboard or any non-conductive material which would interrupt grounding continuity.
- *Flammable liquids in the spray area:* must be kept in approved, grounded containers. Do not use plastic containers. Do not store more than the quantity needed for one shift.
- *All electrically conductive objects or devices in the spray location:* including fluid containers and wash cans, must be properly grounded.

Controller Connections

Overview



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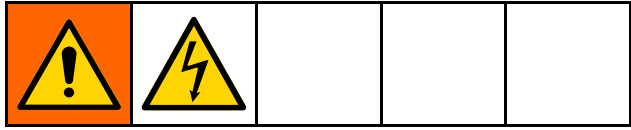


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AA	Back panel
BB	Enclosure
CC	Front Plate with control and display elements
DD	Input Power Connection

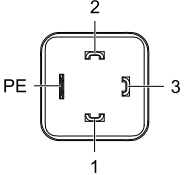
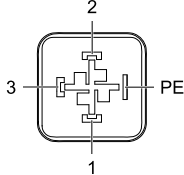
EE	Discrete I/O Cable Connection — use in a system that requires integration
FF	Applicator Power Cable Connection
GG	Ground Connection
HH	CAN Communication Cable Connections

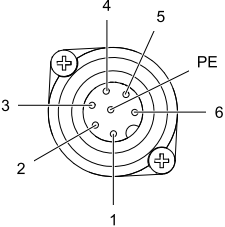
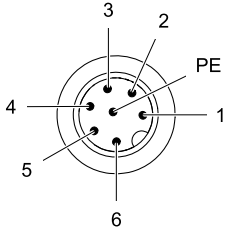
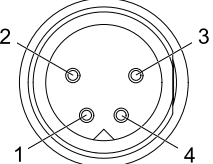
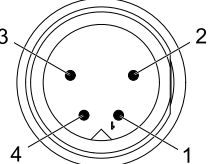
Connections



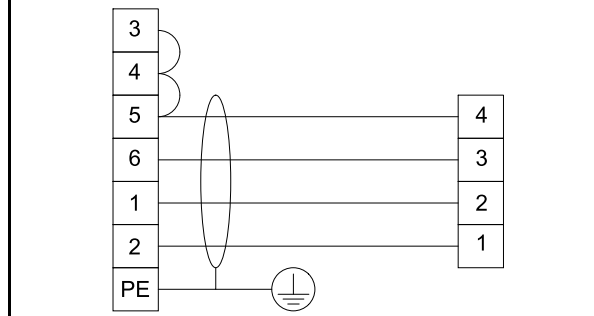
1. Connect the ground wire to the ground connection (GG). Connect the other end to a true earth ground. This connection is required for all installations.
2. Connect the supplied controller input power cord to the input power connection (DD) and secure with the connector screw. This connection is required for all installations.
3. Connect the 7-pin end of the power cable to the applicator power cable connection (FF) on the controller. Connect the 4-pin end of the power cable to the rotary applicator. Follow instructions in the rotary applicator manual. This connection is required for all installations.

The controller can operate at 100–240 VAC (50–60 Hz). Connect the leads to a power source according to local electrical codes. Pin 3 on the input power connection is the system interlock. Pin 3 must have line voltage applied to satisfy the system interlock. When the system interlock pin is connected to line voltage, the **system** icon will appear on the controller. See [Screen Areas, page 39](#).

Controller Input Power Connection		Pin No.	Function	Wire Marking
		1	Neutral conductor power supply	1
		2	Phase (100-240 VAC)	2
		3	System Interlock ON/OFF (100-240 VAC) = ON	3
		PE	Grounding PE	Green/Yellow

Pre-wired Power Cable Connection		Applicator	
Controller		Applicator	
Connector (F)	Cable	Cable	Power Supply Connector
			

Electrical Schematic for this cable:

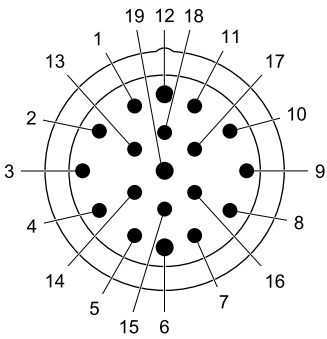
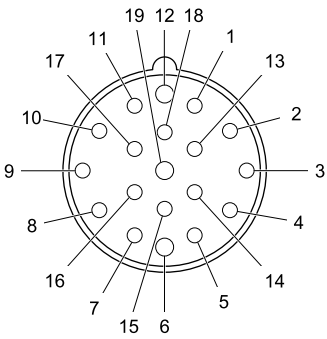


Controller Connections

- Connect the Discrete I/O cable to the Discrete I/O cable connection (EE) on the controller. The Discrete I/O cable is required for any installation that involves integration. Two discrete I/O interlock connections are supplied and must be satisfied. (See [Interlocks, page 8](#).) See [Discrete I/O, page 21](#), for a more detailed explanation of each pin.
- Connect the Graco CAN cables to the CAN cable connections (HH) on the controller. CAN communication is required for remote operation with Graco modules to allow remote configuration and operation of the controller.

NOTE: If CAN communication is used, connect supplied ferrites to CAN cables near the electrostatic controller (see below).

NOTE: CAN communication is Graco proprietary and will not work with other types of CAN.

Discrete I/O cable Connection			
	Pin No.	Function	Wire Color
 <p style="text-align: center;">Controller</p>	1	Preset Select 1 Input	White
	2	Preset Select 2 Input	Brown
	3	Error Reset Input	Green
	4	Remote Enable/Disable Input	Yellow
	5	Electrostatics Enable Input	Gray
	6	Safe-to-Move Output	Pink
	7	Error Output	Blue
	8	I/O Ground	Red
	9	Current Setpoint Input	Black
	10	Voltage Setpoint Input	Purple
	11	Reserved Input	Gray/Pink
	12	I/O Ground	Red/Blue
	13	Actual Spraying Current Output	White/Green
	14	Actual Spraying Voltage Output	Brown/Green
	15	Electrostatics Discharged Output	White/Yellow
	16	Output External Power (24 VDC)	Yellow/Brown
	17	I/O Ground	White/Gray
	18	SAFE POSITION Interlock Input	Gray/Brown
	19	24 VDC Interlock Input	Pink/Brown and Pink/White
 <p style="text-align: center;">Cable</p>			

See [Discrete I/O, page 21](#) for more information.

Discrete I/O

The controller can accept up to 19 I/O interface signals. Systems can be designed to integrate from 1 signal up to all 19 signals.

Discrete I/O input signals are monitored only if the Electrostatic Controller has been placed in the Discrete I/O mode. See [Setup Screen 2 \(Remote Interface\)](#), page 45.

See [Signals](#), page 22 for available signals.

Isolation

The discrete I/O interface signals are isolated from circuit ground. Isolation is required to prevent disturbance of the measurement of the spraying current.

NOTE: The isolation is not designed to isolate hazardous potentials.

I/O Grounding

Pins 8, 12, and 17 are the I/O Ground pins. Connect a ground from each connecting device to one or more of these pins. This will match the potential of the Electrostatic Controller and the connecting device.

Remote Input Operation

In order to accept remote input commands from the discrete I/O interface, the following conditions must be met:

- The discrete I/O interface must be selected by setting Parameter P02 = 1.
See [Setup Screen 2 \(Remote Interface\)](#), page 45.
- The REMOTE Enable input, on the Discrete I/O cable, pin 4, must have 24 VDC (logical "1") applied to it to select REMOTE mode.

Connect the desired input signals. During REMOTE input operation, error confirmation is the only local input (using the keypad) possible.

NOTE: Values for presets P001 – P003 must be set up prior to entering REMOTE mode. Preset P000 is the only preset which can be altered using the Discrete I/O cable signals when the controller has been placed in REMOTE mode. Presets P004 - P250 are not accessible in REMOTE mode.

Remote Output Operation

Connect the desired signals. Digital output signals are generated unconditionally. Output signals require 24 VDC on Output External Power (pin 16) on the discrete I/O Interface cable.

Discrete I/O in CAN Mode

Following is a list of inputs and outputs when operating in CAN mode.

- Safe-to-Move Output
- Error Output
- Output External Power (24 VDC)
- Actual Spraying Current Output
- Actual Spraying Voltage Output
- Electrostatics Discharged Output
- SAFE POSITION Interlock Input
- 24 VDC Interlock Input
- System Interlock
- Electrostatic Enable Input

Signals

Note on Digital Inputs: A “0 (or Low)” is used to indicate that GND or no signal is present. A “1 (or High)” is used to indicate that a 24 VDC signal is present.

Pin	Type	Description															
1	Digital Input	<p>Preset Select 1 (Pin 1) and Preset Select 2 (Pin 2) Inputs</p> <p>Use to specify the Preset selection in REMOTE operation through the discrete I/O interface:</p> <table border="1"> <thead> <tr> <th>Pin 2</th> <th>Pin 1</th> <th></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>Preset P000</td> </tr> <tr> <td>0</td> <td>1</td> <td>Preset P001</td> </tr> <tr> <td>1</td> <td>0</td> <td>Preset P002</td> </tr> <tr> <td>1</td> <td>1</td> <td>Preset P003</td> </tr> </tbody> </table> <p>In REMOTE mode, the values for Preset P000 are based on the analog signals received on the discrete I/O interface. These values will overwrite any existing values in Preset P000.</p> <p>The values for Presets P001–P003 must be entered locally, using the keypad, prior to placing the controller in REMOTE mode. It is not possible to change the values of these Presets remotely.</p> <p>Presets P004–P250 are not accessible in REMOTE mode.</p>	Pin 2	Pin 1		0	0	Preset P000	0	1	Preset P001	1	0	Preset P002	1	1	Preset P003
Pin 2	Pin 1																
0	0	Preset P000															
0	1	Preset P001															
1	0	Preset P002															
1	1	Preset P003															
2	Digital Input																
3	Digital Input	<p>Error Reset Input</p> <p>Use to allow error codes to be acknowledged remotely. Acknowledging an error code does not correct the condition that created the error.</p> <p>0→1 transition: Reset all reported errors</p> <p>NOTE: Additional errors will be logged, regardless of the state of the Error reset. To perform additional error resets, transition from 0 to 1 again.</p>															
4	Digital Input	<p>REMOTE Enable/Disable Input</p> <p>Use to enable or disable REMOTE operation. Enabling REMOTE operation locks out local control and allows the controller to use the discrete I/O interface. When enabled, the remote icon on the display is shown.</p> <p>0: Local control 1: REMOTE control</p>															
5	Digital Input	<p>Electrostatic Enable Input</p> <p>Use to enable or disable electrostatics output.</p> <p>0: Disable electrostatics. 1: Enable electrostatics. All other conditions for activating the electrostatics must be met.</p>															

Pin	Type	Description
6	Digital Output	<p>Safe-to-Move Output</p> <p>Indicates whether the applicator can be moved out of SAFE POSITION to begin paint application. This output is tied to the arc detection blanking time setting on <i>Setup Screen 9</i>. The blanking timer begins counting down when high voltage is enabled. When the timer has reached zero, the Safe-to-Move Output is switched from Inactive to Active.</p> <p>Inactive: Applicator must not be moved out of SAFE POSITION because arc detection is blanked and electrostatics are activated.</p> <p>Active: Applicator allowed to be moved out of SAFE POSITION because arc detection is active or electrostatics are deactivated.</p> <p>For more information, see Safe Position Mode, page 31.</p> <p>NOTE: The voltage level for a digital output depends on the type of output selected on Setup Screen 5 (Digital Output Type Select), page 47.</p>
7	Digital Output	<p>Error Output</p> <p>Used to signal detection of an error condition.</p> <p>Inactive: No error condition detected.</p> <p>Active: An error condition has been detected and reported.</p> <p>NOTE: Reset by Error Reset input or by local confirmation.</p> <p>NOTE: The voltage level for a digital output depends on the type of output selected on Setup Screen 5 (Digital Output Type Select), page 47.</p>
8	Ground	<p>I/O Ground</p> <p>Reference potential for I/O interface signals.</p>
9	Analog Input	<p>Current Setpoint Input</p> <p>Use to set the current setpoint (μA) nominal value. The REMOTE current setpoint input applies when Preset 0 (P000) is selected and the controller is in REMOTE operation.</p> <p>This signal is used to create the current setting in P000. The larger the input value, the greater the electrostatics current setpoint.</p> <p>0 – 10 V (received input) \rightarrow 0 – 150 μA (desired electrostatic output) OR 4 – 20 mA (received input) \rightarrow 0 – 150 μA (desired electrostatic output)</p> <p>The type of input is selected on Setup Screen 3 (Analog Input Type Select), page 46</p>
10	Analog Input	<p>Voltage Setpoint Input</p> <p>Use to set the voltage setpoint (kV) nominal value. The REMOTE voltage setpoint input applies when Preset 0 (P000) is selected and the controller is in REMOTE operation.</p> <p>The input voltage or current is used to create a relational output voltage value for the applicator electrostatics power supply. The larger the input value, the greater the electrostatics voltage at the applicator.</p> <p>0 – 10V (received input) \rightarrow 0 – <i>max kV*</i> (desired electrostatic output at the applicator) OR 4 – 20mA (received input) \rightarrow 0 – <i>max kV*</i> (desired electrostatic output at the applicator)</p> <p>The type of input is selected on Setup Screen 3 (Analog Input Type Select), page 46</p> <p>* <i>max kV</i> = 100 kV (solventborne) or 60 kV (waterborne)</p>

Pin	Type	Description
11	Digital Input	Reserved for future use.
12	Ground	I/O Ground Reference potential for discrete I/O interface signals.
13	Analog Output	<p>Actual Spraying Current Output</p> <p>Use to indicate the actual spraying current (0 – 150 μA). 24 VDC must be applied to Pin 16 to enable this function.</p> <p>The voltage or current signal present on this pin is proportional to the spraying current of the electrostatic power supply. The larger the value on this pin, the greater the output current at the applicator.</p> <p>0 – 150 μA (applicator output) \rightarrow 0 – 10V or 4 – 20 mA (pin output)</p> <p>The type of output is selected on Setup Screen 4 (Analog Output Type Select), page 46</p>
14	Analog Output	<p>Actual Spraying Voltage Output</p> <p>Use to indicate the actual spraying voltage (0– <i>max kV</i>*). 24 VDC must be applied to Pin 16 to enable this function.</p> <p>The voltage or current signal present on this pin is proportional to the spraying voltage of the electrostatic power supply. The larger the value on this pin, the greater the output voltage at the applicator.</p> <p>0 – <i>max kV</i>* (applicator output) \rightarrow 0 – 10V or 4 – 20 mA (pin output)</p> <p>The type of output is selected on Setup Screen 4 (Analog Output Type Select), page 46</p> <p>* <i>max kV</i> = 100 kV (solventborne) or 60 kV (waterborne)</p>
15	Digital Output	<p>Electrostatics Discharged Output</p> <p>Use to indicate when electrostatics have been fully discharged. Set the electrostatic discharge timer setting on <i>Setup Screen 10</i> (Configuration C2). The discharge timer begins counting down when electrostatics have been disabled. When the timer reaches zero, the Electrostatics Discharged Output is switched from Inactive to Active.</p> <p>Inactive: Electrostatic voltage not discharged</p> <p>Active: Electrostatic voltage discharge time has elapsed.</p> <p>NOTE: The voltage level for a digital output depends on the type of output selected on Setup Screen 5 (Digital Output Type Select), page 47.</p>
16	Output External Power	<p>Output External Power (24 VDC)</p> <p>Apply power (24 VDC / 100 mA) to this pin to power the output circuitry. This voltage is to be supplied externally, i.e., from PLC. Can be omitted if the outputs are not required.</p>
17	Ground	I/O Ground Reference potential for discrete I/O interface signals.

Pin	Type	Description
18	Digital Input	<p>SAFE POSITION Interlock Input</p> <p>The controller will not activate the electrostatics unless this and all other interlock inputs have been satisfied. If satisfied in another manner, this interlock can be disabled by changing switch 2 to the ON position on the controller main circuit board. See Disable Controller Interlocks, page 10.</p> <p>The SAFE POSITION interlock does not deactivate electrostatics when the signal is not satisfied. This signal indicates that a robot or applicator is in a position in which it is safe to activate electrostatics without arc detection.</p> <p>0: Interlock not satisfied: If electrostatics are off, electrostatics disabled. If electrostatics are on, no change to electrostatics.</p> <p>1: Interlock satisfied; electrostatics activation is not locked by this input.</p> <p>NOTE: Switching from 1 to 0 does not deactivate electrostatics.</p> <p>Symbol A10 on the display screen (see Screen Areas, page 39) will show that this signal is satisfied.</p>
19	Digital Input	<p>24 VDC Interlock Input</p> <p>The controller will not activate electrostatics unless this and all other interlock inputs have been satisfied. If satisfied in another manner, this interlock can be disabled by changing switch 1 to the ON position on the controller main circuit board. See Disable Controller Interlocks, page 10.</p> <p>0: Interlock not satisfied; electrostatics disabled</p> <p>1: Interlock satisfied; electrostatics activation is not locked by this input.</p> <p>Symbol A9 on the display screen (see Screen Areas, page 39) will show that this signal is satisfied.</p>

Analog Inputs

The analog inputs are used to set certain parameters remotely by a PLC. The inputs can be configured to be either voltage or current inputs. This setting applies to all inputs simultaneously.

Electrical Specifications

Use Parameter P03 (See [Setup Screen 3 \(Analog Input Type Select\)](#), page 46) to select the input signal type.

Voltage input mode, P03 = 0

Parameter	Value
Nominal input range	0 – 10 VDC
Input impedance	4.7 kΩ
Maximum allowed input voltage	30 VDC
Reverse polarity protection	Yes
Accuracy	1% typical
Recommended source impedance	< 10 Ω

Current input mode, P03 = 1

Parameter	Value
Nominal input range	4 – 20 mA (sinking)
Input impedance	100 Ω
Maximum allowed input voltage	30 V
Reverse polarity protection	Yes
Input current limit	Yes, 25 mA
Accuracy	1% typical

Analog Outputs

The analog outputs are used to communicate actual values to other devices, such as a PLC. The outputs can be configured to be either voltage or current outputs. This setting applies to all outputs simultaneously. The analog outputs require an external 24 VDC voltage to be connected to Output External Power (discrete I/O interface, pin 16).

Electrical Specifications

Use Parameter P04 (See [Setup Screen 4 \(Analog Output Type Select\)](#), page 46) to select the output signal type.

Voltage output mode, P04 = 0

Parameter	Value
Output voltage range	0 – 10 VDC
Output impedance	< 10 Ω (sourcing)
Short circuit protection	0 – 30 VDC
Accuracy	1% typical

Current output mode, P04 = 1

Parameter	Value
Output current range	4 – 20 mA
Output impedance	< 10 Ω (sourcing)
Short circuit protection	0 – 30 V
Accuracy	1% typical
Maximum load resistance	1 kΩ (0–20 VDC)
Minimum load resistance	0 Ω (0–20 VDC)

Digital Inputs

The digital inputs are used to control the ProBell Electrostatic Controller from a remote device, such as a PLC. All digital inputs are sinking inputs. In order to accept input signals from an external device through the Discrete I/O interface, the REMOTE Enable/Disable input must first be activated.

Electrical Specification

Parameter	Value
Input type	Current sinking
Input impedance	>10 k Ω
Maximum allowed input voltage	30 VDC
Minimum required "1" input voltage	> 10 VDC
Maximum allowed "0" input voltage	< 4 V (Open inputs have "0" level)

Digital Outputs

The digital outputs provide status signals to other devices, such as a PLC. The outputs can be configured to be sinking or sourcing outputs. This setting applies to all digital outputs simultaneously. The digital outputs require an external 24 VDC voltage to be connected to Output External Power (discrete I/O interface, pin 16).

Electrical Specification

Use **Parameter P05** (see [Setup Screen 5 \(Digital Output Type Select\)](#), page 47) to select the output signal type.

Table 2 Sinking Output Mode: P08 = 0

Parameter	Value
Output type	Sinking (P08 = 0)
Output impedance	1 k Ω
Maximum allowed output voltage	30 VDC
Short circuit protection	0 – 30 VDC
Inactive Voltage Level	High impedance (set by the pull-up resistor)
Active Voltage Level	Low/GND (Negative logic)

NOTE: Sinking digital outputs require a pull-up to the connecting device's logic level "1" (e.g., 24 VDC).

Table 3 Sourcing Output Mode: P08 = 1

Parameter	Value
Output type	Sourcing (P08=1)
Output impedance	1.8 k Ω
Maximum allowed output voltage	30 VDC
Short circuit protection	0 – 30 VDC
Inactive Voltage Level	High impedance (set by pull-down resistor)
Active Voltage Level	High/Voltage at Pin 16 (Positive logic)

NOTE: Sourcing digital outputs require a pull-down to the connecting device's logic level "0" (e.g. GND).

Discrete I/O Interface Connections

The electrical connections for the Discrete I/O interface pins are shown here.

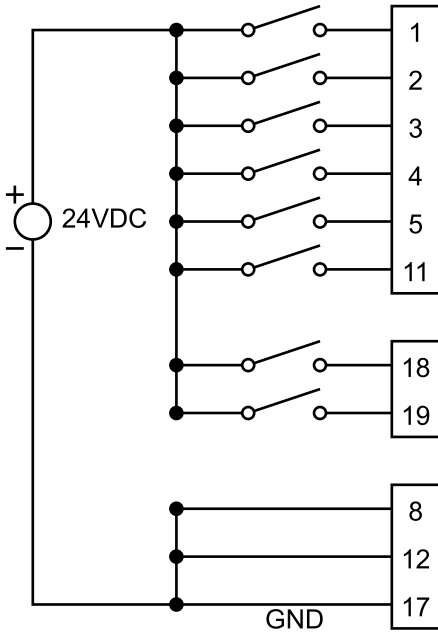


Figure 1 Digital Inputs

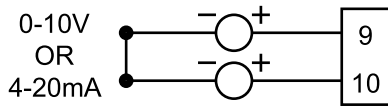


Figure 2 Analog Inputs

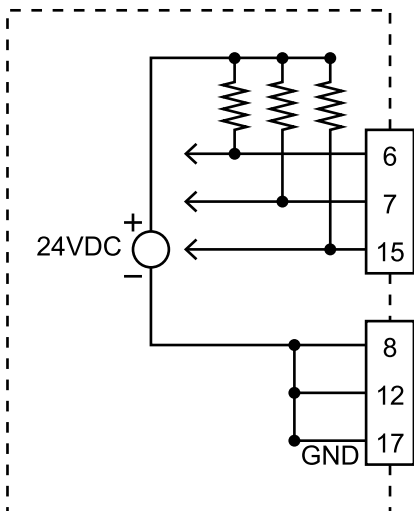


Figure 3 Digital Outputs — Sinking Mode with external pull-up resistors shown

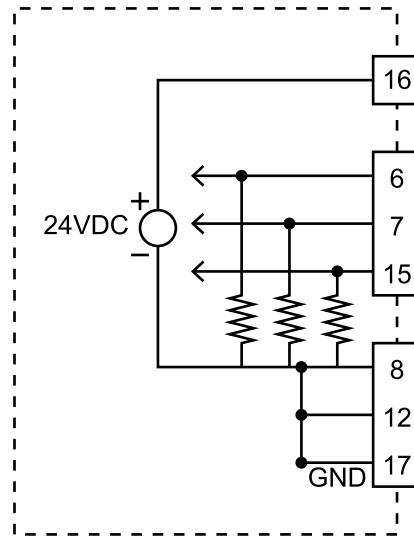


Figure 4 Digital Outputs — Sourcing Mode with external pull-down resistors shown

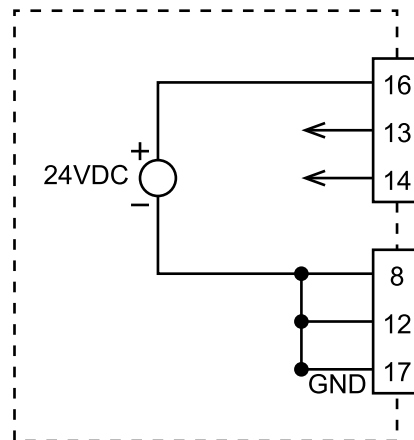


Figure 5 Analog Outputs

Operation Modes and Timing Diagrams

This section is intended to be a guide for how an electrostatic spray system should operate and how it should be integrated into a spray system. As the ProBell Electrostatic Controller only controls electrostatics, some components of a spray system are generalized. Where possible, the inputs and outputs available on the ProBell Electrostatic Controller are called out by name. The timing diagrams use “0” to indicate a signal or function is off or inactive and “1” to indicate a signal or function is on or active.

A spray system has several modes of operation. These modes describe the system state, but are not selectable by the user on the ProBell Electrostatic

Controller. It is important that these modes are understood for proper integration and safety.

The operation modes are:

- Standby: Electrostatics held in off mode
- SAFE POSITION: Verify the applicator position before enabling the electrostatics
- Spray: Fluid and electrostatics enabled, applicator in motion
- Error handling
- Purge: Flush solvent is present, no electrostatics, applicator not in motion

Standby Mode

Standby mode is when the electrostatics are off because the system is not ready to perform a spraying operation. During standby mode, the following conditions may exist:

- The system is powered down
- Fluid is being loaded

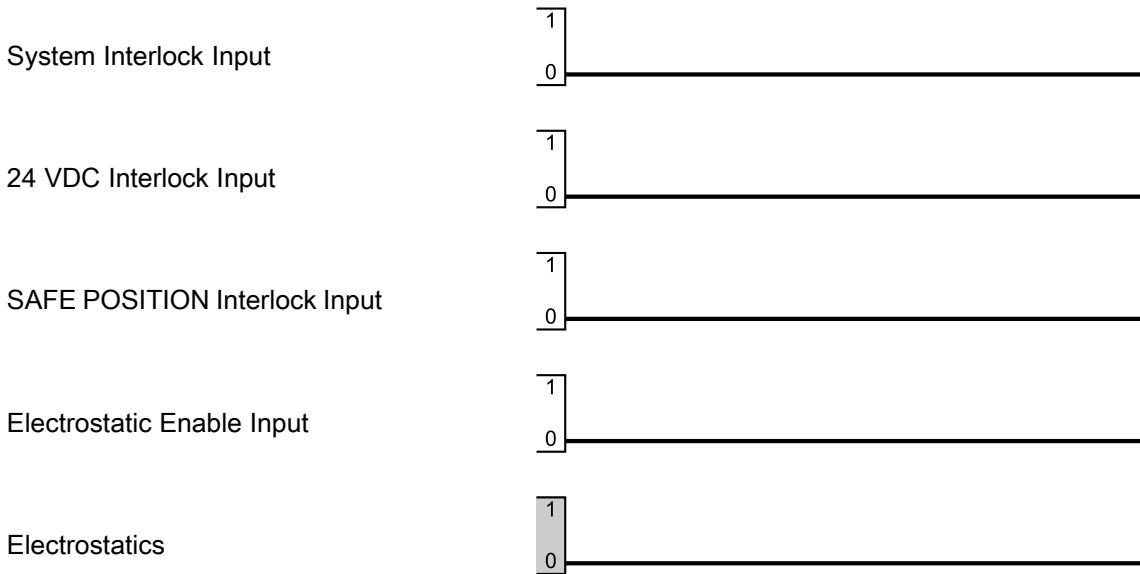
The controller deactivates the electrostatics (if electrostatics are activated), or prevents the electrostatics from being activated, when any or a combination of the following signals are inactive:

- System interlock (power connector)
- 24 VDC Interlock
- Electrostatic Enable

NOTE: The SAFE POSITION input does not deactivate electrostatics if they are already on. The SAFE POSITION input only prevents electrostatics from being activated.

All input signals shown here must be active for the controller to enable electrostatics. See [Signals, page 22](#).

Standby Timing Diagram



: = Input

: = Output

Safe Position Mode

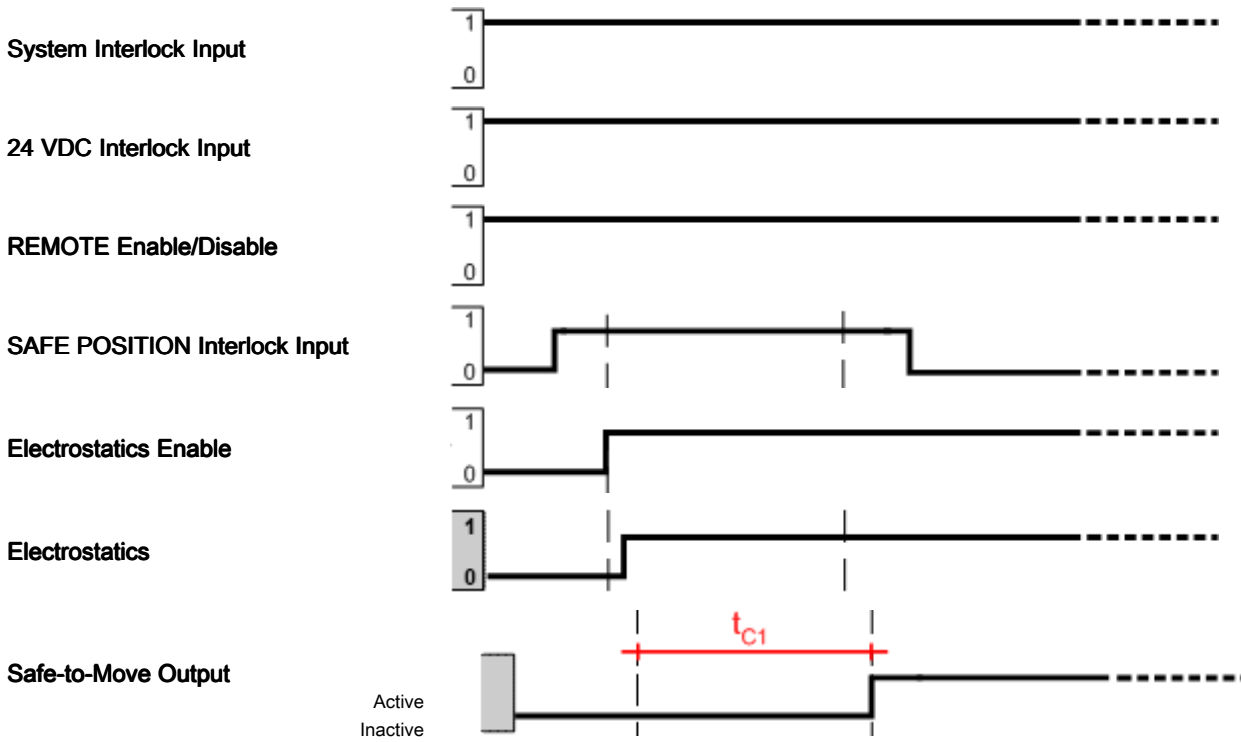
The SAFE POSITION is defined as a position where the applicator electrode is at least 6 inches away from any grounded object. While many such positions may exist, one position should be selected as the applicator SAFE POSITION. When the applicator is in the SAFE POSITION, electrostatics can be activated, blanking time allowed to elapse, and arc detection activated. The applicator should remain in the SAFE POSITION until the system reaches full voltage and arc detection is active.

To enable electrostatics using SAFE POSITION:

1. Satisfy the System and 24 VDC interlocks.
2. If controlling the system through the discrete I/O interface, set the REMOTE input high.
3. Move the applicator to SAFE POSITION. Then set the SAFE POSITION interlock high to tell the Electrostatic Controller that the applicator is in SAFE POSITION and that the electrostatics can be activated.
4. Set the Electrostatic Enable input high or activate the electrostatics.
5. The Electrostatic Controller activates the electrostatics at the applicator.
6. The Safe-to-Move output is activated when the time defined by the arc detection blanking parameter (C1) value, as defined on [Setup Screen 11 \(Transition Time\), page 50](#), has elapsed after receiving the Electrostatic Enable input signal. The Safe-to-Move signal indicates that the controller has determined that the applicator electrostatics are ready for application and that the applicator can move freely. Arc detection is deactivated during the blanking time. The C1 setting defines the length of time before arc detection is enabled.

When the applicator leaves the SAFE POSITION, the SAFE POSITION Interlock is removed, which leaves it not satisfied. This does not disable the electrostatics. If the electrostatics are deactivated, the robot needs to return to the SAFE POSITION and reapply the SAFE POSITION Interlock input in order to activate the electrostatics.

Safe Position Timing Diagram



Spray Mode

The system is in spray mode when the applicator is ready to leave SAFE POSITION or is in motion and electrostatics are enabled.

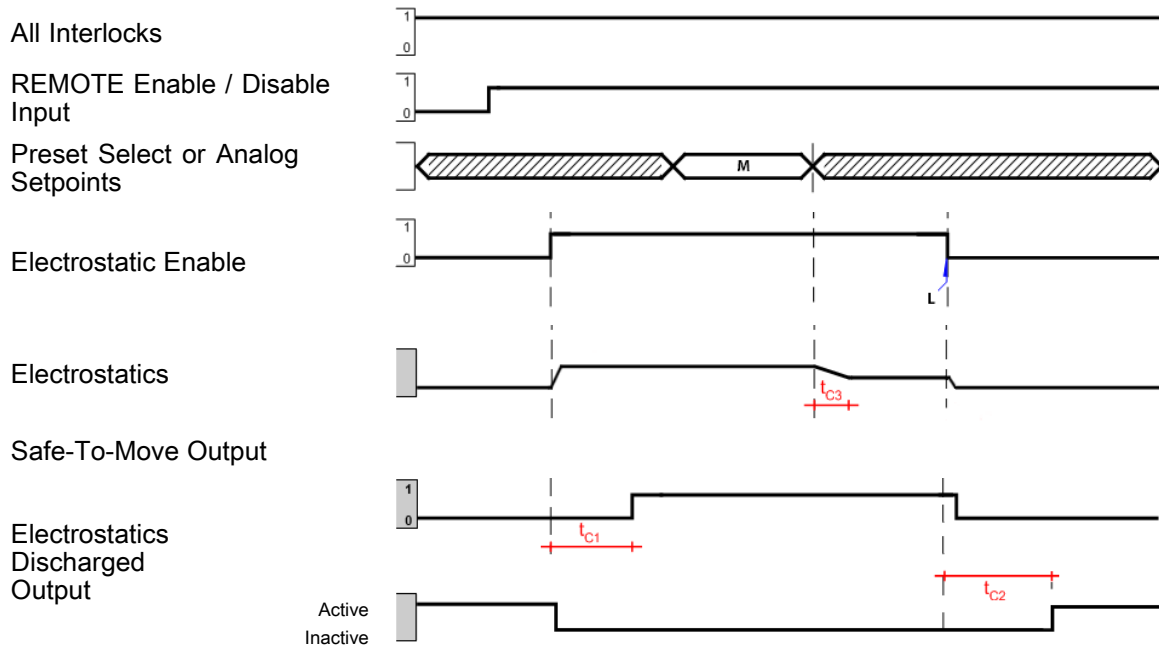
To start spraying:

1. Satisfy all interlocks (shown as “All Interlocks”)
2. If spraying using the Discrete I/O interface, enable REMOTE operation using the Remote Enable/Disable input.
3. Set the desired voltage and current:
 - a. If spraying in local mode using the Electrostatic Controller interface, select the active Preset (P000-P003) using the **<P>** keys. Set the voltage and current setpoints using the **<** and **>** keys (see [Run Screen 1 \(Electrostatic Readings\)](#), page 52).
 - b. If using the discrete I/O interface, select the active Preset (P000-P003) using Preset Select 1 and Preset Select 2. If analog control is desired, select Preset P000. Use the Current Setpoint Input and Voltage Setpoint input to adjust the electrostatics.
 - c. If using the CAN interface, select the desired voltage and current.
4. Activate the electrostatics. If spraying in local mode using the Electrostatic Controller interface, activate the electrostatics using the **⏻** key. If using the discrete I/O interface, activate the electrostatics using the Electrostatic Enable Input.
5. If spraying in REMOTE mode, monitor the Safe-to-Move Output to know when the blanking time has passed and arc detection is enabled. The blanking time is defined by Parameter C1 (see [Setup Screen 9 \(Blanking Time\)](#), page 49).
6. Change the desired electrostatic output:
 - a. If spraying in local mode using the Electrostatic Controller interface, change the active Preset (P000-P003) using the **<P>** keys. Set the voltage and current setpoints using the **<** and **>** keys (see [Run Screen 1 \(Electrostatic Readings\)](#), page 52).
 - b. If using the discrete I/O interface, change the active Preset (P000-P003) using Preset Select 1 and Preset Select 2. If analog control is desired, select Preset P000. Use the Current Setpoint Input and Voltage Setpoint input to adjust the electrostatics.
 - c. If using the CAN interface, change the desired voltage and current.

The electrostatics will transition to the desired output over the transition time. This time is set by Parameter C3 (see [Setup Screen 11 \(Transition Time\)](#), page 50). The transition time is not used during activation (0 to setpoint) or deactivation (setpoint to 0).
7. Disable the electrostatics when done spraying. If spraying in local mode using the Electrostatic Controller interface, deactivate the electrostatics using the **⏻** key. If using the discrete I/O interface, deactivate the electrostatics using the Electrostatics Enable Input.
8. If spraying in REMOTE mode, monitor the Electrostatics Discharged Output to know when the discharge time has passed and the system is fully discharged. The discharge time is defined by Parameter C2 (see [Setup Screen 10 \(Discharge Timer\)](#), page 49).

The diagram below shows discrete I/O REMOTE mode and shows three parts of electrostatic spraying: activate, setpoint change, and deactivate. Blanking time t_{C1} , transition time t_{C2} , and discharge time t_{C3} are also illustrated.

Spray Timing Diagram



□ : = Input

■ : = Output

L – Any method used to disable electrostatics

M – Setting Change

t_{C1} – Blanking Time as set by parameter C1

t_{C2} – Discharge Time as set by parameter C2

t_{C3} – Transition time as set by parameter C3

Error Handling Mode

The system is in error handling mode when an error occurs that disables electrostatics. When an error occurs, an error code is generated. This error code is shown in red on the Electrostatic Controller user interface in location A5 and Discrete I/O Error Output signal is activated.

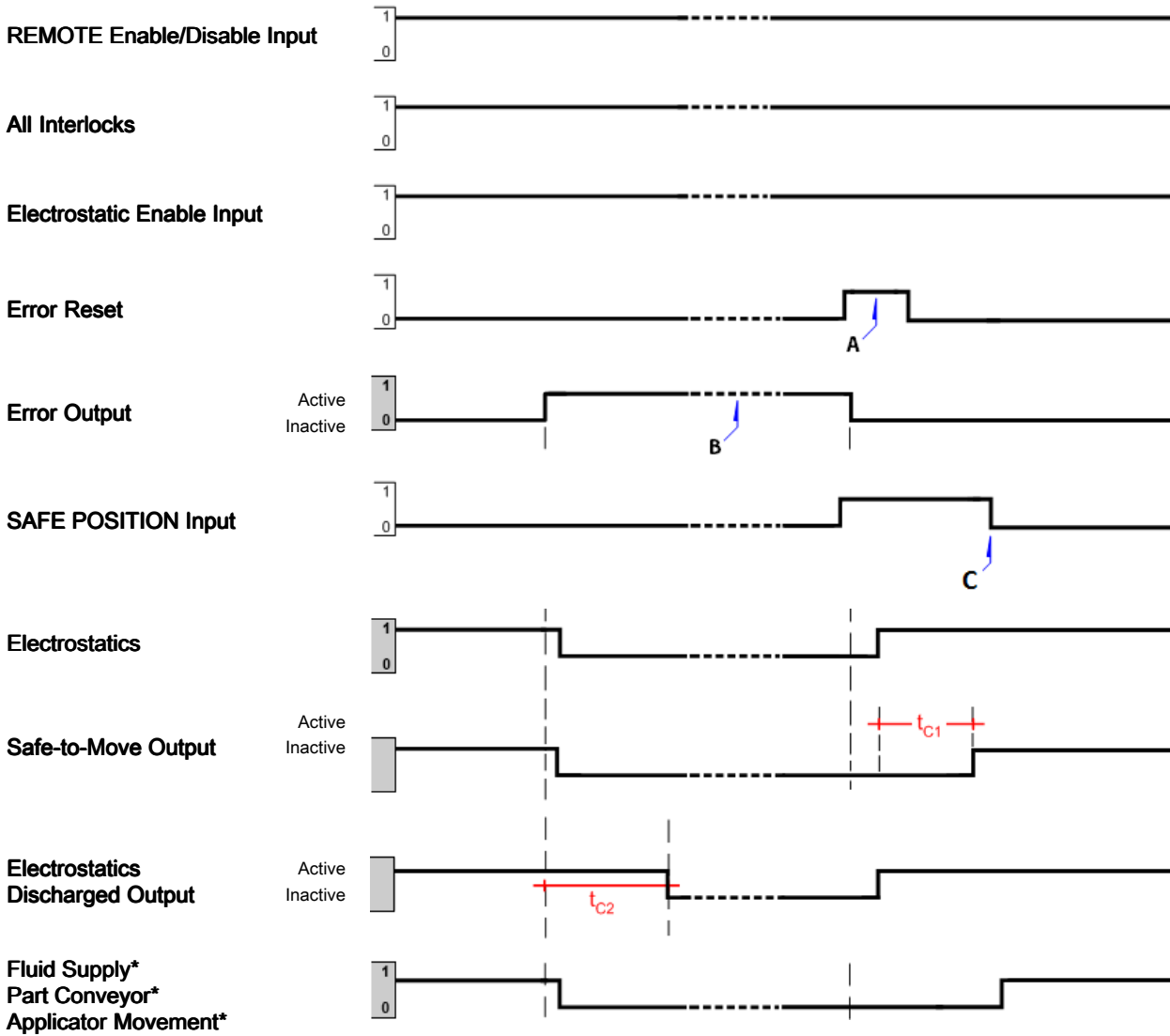
Handle an error with the following procedure:

1. Fix the condition that caused the error code (see [Troubleshooting, page 62](#)).
2. Acknowledge the error code:
 - a. If using the discrete I/O interface, acknowledge the error code using Discrete I/O Error Reset, (Pin 3).
 - b. If in local mode, acknowledge the error code using the **<P>** button (T11) on the Electrostatic Controller user interface.

3. Move the robot to SAFE POSITION. Satisfy the SAFE POSITION interlock.
4. Activate the electrostatics.
5. The Blanking Time passes; Safe-to-Move output is activated.

The diagram shows an example of error handling using the discrete I/O interface.

Error Handling Timing Diagram



□ : = Input

■ : = Output

A: Hold high until error output is low

B: Fix error condition

C: Robot has begun movement from SAFE POSITION after Safe-to-Move

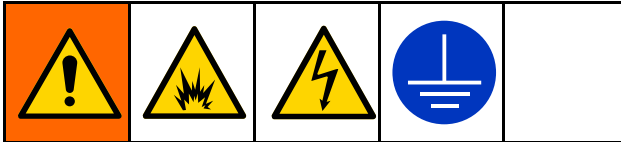
t_{c1} : Blanking Time as set by parameter t_{c1}

t_{c2} : Discharge Time as set by parameter t_{c2}

* Not controlled by Electrostatic Controller

Purge Mode

During Purge mode flush solvent is present, electrostatics are disabled, and the applicator is not in motion.



To avoid fire, explosion, and electric shock, always turn the electrostatics off when flushing, cleaning, or servicing equipment. Always ground equipment and waste container.

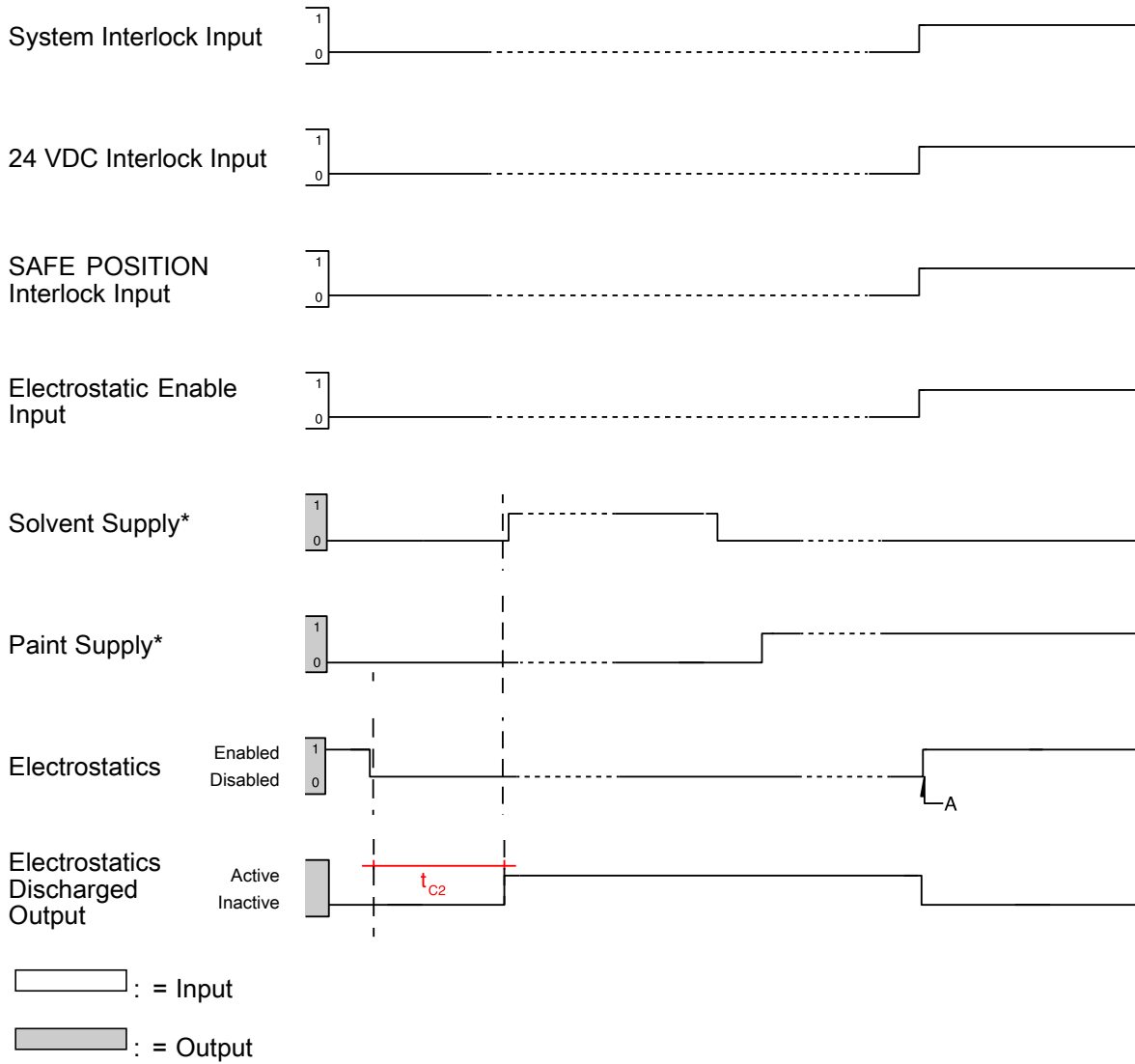
This can be accomplished by using one of the interlock inputs or through control of the Electrostatic Enable pin. This can also be accomplished by powering down the controller.

Disable the electrostatics any time the solvent supply is activated. Before enabling electrostatics again, ensure that the paint and dump lines are completely free of solvent. Determine any time and volume requirements for paint to be loaded. Ensure that the electrostatics are disabled for the entire load sequence.

Deactivate the electrostatics using one or combination of the following signals:

- System Power Interlock: Low
- 24 VDC Interlock: Low
- Electrostatic Enable Input: Low
- Powering off the Electrostatic Controller by pressing the **off** button.

Purge Timing Diagram

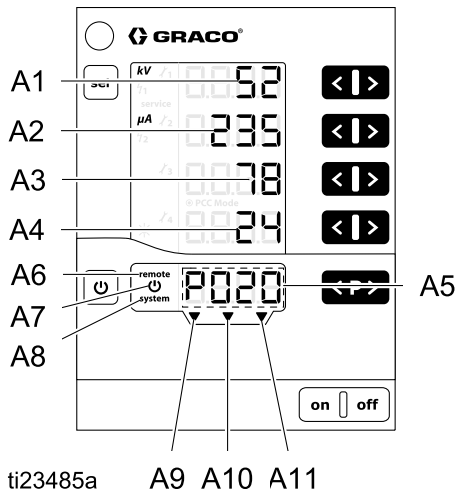


* Not controlled by Electrostatic Controller
 A: Fluid lines free of solvent, OK to activate electrostatics

Controller Display and Features

Screen Areas

There are five areas on the screen used for numerical information. Six additional areas provide non-numerical information.



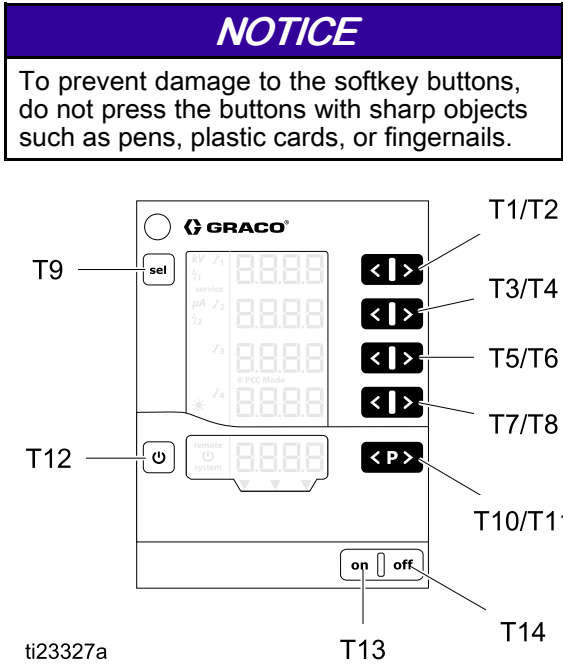
Designation	Function
A1–A4	Displays actual values, preset values, and system parameters. Flashes when the possible range is exceeded.
A5	Displays Preset number, error diagnosis codes, and status information.
A6	REMOTE operation enabled
A7	Electrostatics active/triggered
A8	System interlock connection satisfied
A9	SAFE POSITION Interlock satisfied

A10	24 VDC Interlock satisfied
A11	Electrostatic Enable input is Active

Icons

Icon	Explanation
<i>kV</i>	Electrostatic voltage (displayed in kV)
<i>μA</i>	Electrostatic current (displayed in μA)
	Electrostatics activate/trigger
remote	REMOTE operation active. Blinks when the keyboard lock is active
system	System interlock satisfied
	Display backlight illumination (0–8)
	Maintenance reminders
	Static arc setting
	Dynamic arc setting
service	One of the maintenance counters has reached 0.

Input Keys and Switches



Designation	Function
T1-T8	Input keys for preset values and system parameters or configurations. Used to increase or decrease values shown.
T9	Switch between system parameters (P00–P07) and system configurations (C0–C3)
T10-T11	Preset change.
T12	Electrostatics activate/trigger. Switch between Run and Setup screens.
T13	Controller power on.
T14	Controller power off.



Additional Features

Keyboard Lock

The keyboard lock can be used to prevent changes to individual voltage and current parameter values within the Presets while the controller is operating locally. When the keyboard lock is active, the controller continues to allow:

- Preset selection
- Display of preset values of the current Preset
- Display of the actual values
- Error acknowledgement

Activate/deactivate the keyboard lock

1. Press the  key and the  (T8) key at the same time.
2. The **remote** display blinks when the keyboard lock is activated.
3. The keyboard lock is cancelled by pressing the same key combination again.

The keyboard lock status remains stored, when switching the controller off and on. The keyboard lock is cancelled if factory defaults are restored.

NOTE: The keyboard lock is independent from the screen lock. The screen lock feature is present in REMOTE operation.



Screen Lock

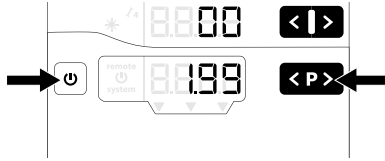
When in REMOTE mode, the available keypad functions and available screens are limited because a screen lock is active. During screen lock, the available functions are limited to:

- Display of active preset values
- Display of the actual values
- Error acknowledgement

NOTE: If the keyboard was locked when remote mode is entered, the **remote** display will continue to blink.

Checking the Software Version

1. Press the  key and the  button at the same time.




2. The software version is displayed as long as the keys are held.

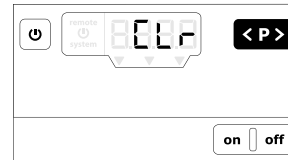
Restore Factory Defaults


All parameters (**except P00**) and configurations (C0 – C3), as well as all user-defined values, will be overwritten with factory default. Any active keyboard lock or screen lock will be removed.

Maintenance counts, state (active/non-active) and setpoints are NOT reset.

NOTE: By restoring factory defaults, except for display backlight setting, all user-made settings will be set to factory default.

1. Press **off** on the controller.
2. Press and hold .
3. Press **on** on the controller. The **CLr** display blinks.



4. Wait for approximately 5 seconds, until **CLr** disappears.
5. Release the .
6. All values are reset.

Auto Power Save Mode

The display backlight turns off automatically after five minutes of electrostatics inactivity. Touching any key will turn the display backlight back on.

Setup

The Electrostatic Controller has setup screens that define how the controller functions. This setup is saved in the equipment memory, even when power is removed. The controller is set up by using the system parameters and configuration screens. These values can be adjusted in the setup screens.

1. Press **on** to turn on the controller.
2. To access the Setup Screens, press and hold **U** for 5 seconds from any Run Screen. Press buttons T1/T2 to move between Setup Screens 0-7 (Parameters).

NOTE: Press **sel** to access Setup Screens 8–11 (Configuration). Press buttons T1/T2 to move between Screens 8–11. To return to Setup Screen 1, press **sel** again.

3. To return to the Run Screens, press **U** from any Setup Screen.

This table summarizes the system parameters (P00–P07) that are defined using Setup Screens 0–7. The table also shows the configurations (C0–C3) that are defined using Setup Screens 8–11. Each Setup Screen is then described in detail in the sections that follow the table.

PARAMETERS				
Setup Screen	Display (A1) Value	Description	Display (A3) Values	Display (A4) Value
0	P00	<i>Applicator Type</i> Display A2: APP Use to define applicator type and features. This selection is set in the factory and cannot be changed. This selection is not overwritten if a Factory Default Reset is performed.	0: Standard (solventborne) 1: Waterborne	Std UUb
1	P01	<i>Electrostatic Control Mode</i> Display A2: Ctrl Define how electrostatics generation is controlled. This selection is set to 1 (current) in the factory and cannot be changed.	1: Current Control	CUrr
2	P02	<i>Remote Interface</i> Display A2: bUS Use to select the remote interface from which the controller will accept external control.	0: Off 1: Discrete I/O (default) 2: CAN	oFF dio CAn
3	P03	<i>Analog Input Type</i> Display A2: Ai Use to select the input signal type for the discrete I/O analog inputs.	0: Voltage(default) 1: Current	Volt CUrr
4	P04	<i>Analog Output Type</i> Display A2: Ao Use to select the output signal type for the discrete I/O analog outputs.	0: Voltage (default) 1: Current	Volt CUrr
5	P05	<i>Digital Output Type</i> Display A2: do Use to select the output signal type for the discrete I/O digital outputs.	0: Sinking (default) 1: Sourcing	

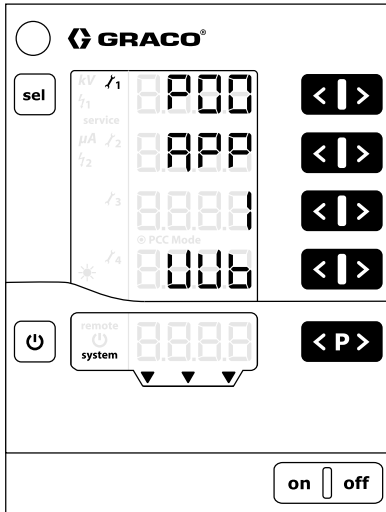
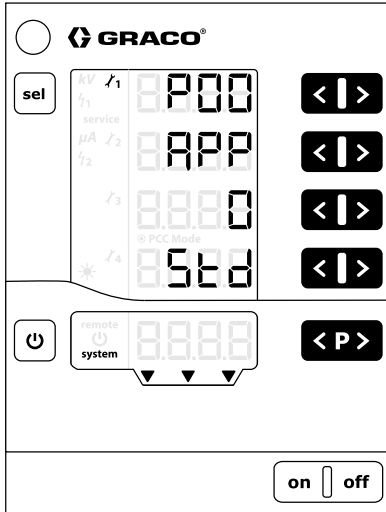
PARAMETERS				
Setup Screen	Display (A1) Value	Description	Display (A3) Values	Display (A4) Value
6	P06	<i>CAN Purpose ID</i> Use to set the purpose ID for CAN communication.	0–32 0 (default)	Pid
7	P07	<i>Log level</i> Display A2: LoG Use to designate how much information is logged in the system.	0–4 0 (default)	LoG

CONFIGURATION			
Setup Screen	Display (A1) Value	Description	Display (A2) Values
8	C0	<i>Arc detection averaging interval Δt [sec]</i> Use to set the time interval that the controller will use to calculate the dynamic arc.	0.01 – 0.5 by 0.01 0.10 (default)
9	C1	<i>Arc detection blanking time setpoint [sec]</i> Use to set the amount of time after turning on the high voltage during which arc detection is suppressed.	0.0 – 30.0 by 0.1 0.5 (solventborne default) 10.0 (waterborne default)
10	C2	<i>Discharge timer setpoint [sec]</i> Use to set the time needed to fully discharge after turning off the electrostatics.	5.0 – 120.0 by 0.1 5.0 (solventborne default) 60.0 (waterborne default)
11	C3	<i>Transition Time Interval [sec]</i> Use to set the interval of transition time between electrostatic setpoints.	0.0 – 5.0 by 0.1 0.0 (default)

Setup Screen 0 (System Type)

Setup Screen 0 (Parameter P00) displays the type of electrostatic applicator (APP) in use. The Electrostatic Controller is factory set to 0 (Std) or 1 (UUb) and cannot be changed.

NOTE: This parameter is not overwritten if a Factory Default Reset is performed.

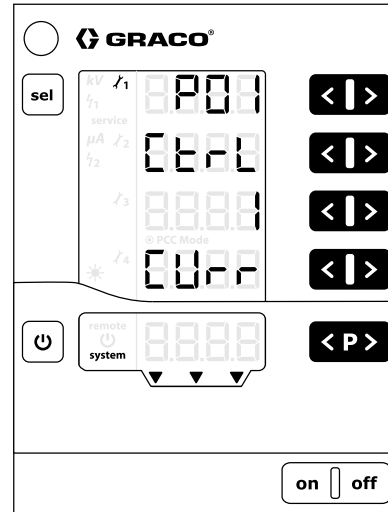


Std: Solventborne product: 100 kV maximum

UUb: Waterborne product: 60 kV maximum

Setup Screen 1 (Electrostatics Control Mode)

Setup Screen 1 (Parameter P01) displays the electrostatics control mode (Ctrl) in use. The Electrostatic Controller is factory set to Current (1, CUrr) and cannot be changed.



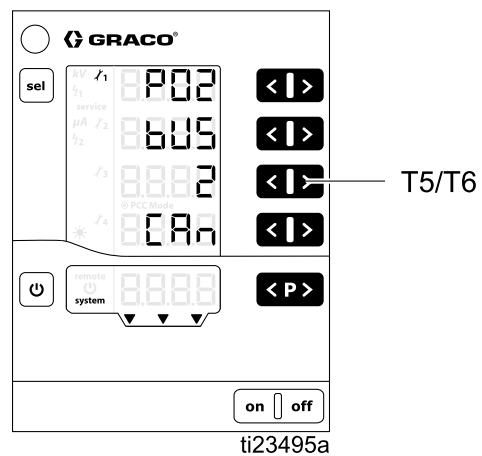
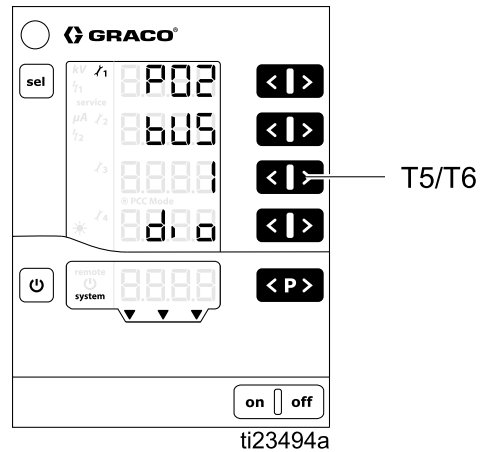
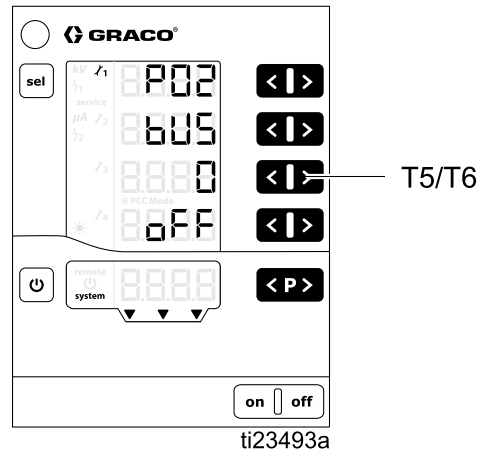
Setup Screen 2 (Remote Interface)

Use Setup Screen 2 (Parameter P02) to select the remote interface (bUS) from which the controller will accept external control. Press buttons T5/T6 to change the setting.

The options are:

- **0 = oFF**: Discrete I/O interface is disabled (local operation).
- **1 = dio**: Discrete I/O interface is enabled. This selection is the default. See [Discrete I/O, page 21](#), for more information.
- **2 = CAn**: CAN interface is enabled. The CAN interface is used to communicate with Graco modules. When CAN interface is enabled, all inputs except Electrostatic Enable are disabled. All outputs function normally. [See [Discrete I/O, page 21](#).]

NOTE: The controller must be restarted for a change to this parameter to take effect.

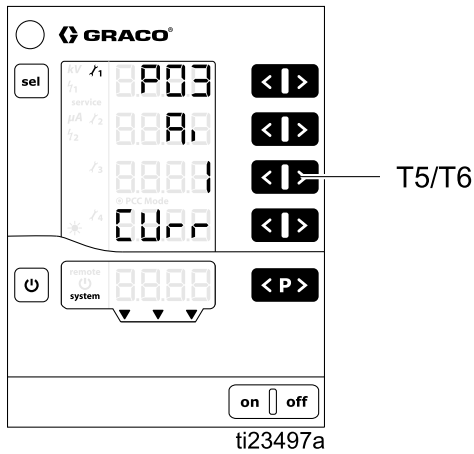
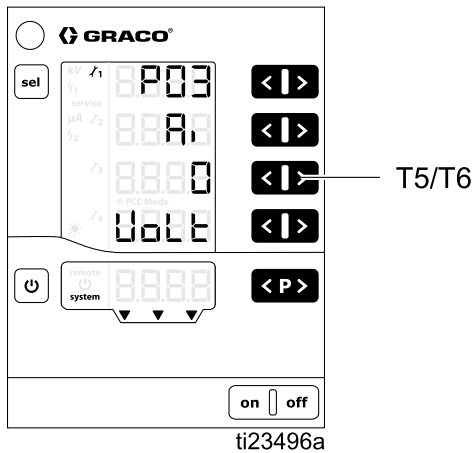


Setup Screen 3 (Analog Input Type Select)

Use Setup Screen 3 (Parameter P03) to select the input signal type for the discrete I/O interface analog inputs (Ai). Press buttons T5/T6 to change the setting. The options are:

- **0 = VoLt:** Analog voltage inputs are voltage type (0 - 10 V). This selection is the default.
- **1 = CUrr:** Analog current inputs are current type (4 - 20 mA).

This setting applies to Current Setpoint and Voltage Setpoint analog inputs for the Discrete I/O interface. See [Discrete I/O, page 21](#), for more information.

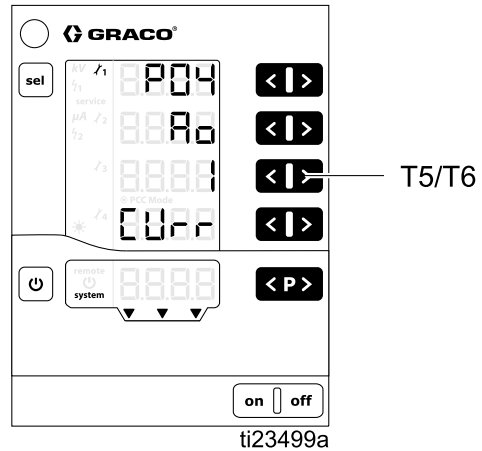
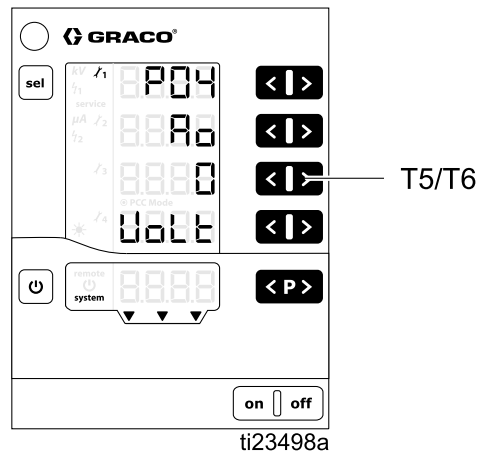


Setup Screen 4 (Analog Output Type Select)

Use Setup Screen 4 (Parameter P04) to select the output signal type for the discrete I/O interface analog outputs (Ao). Press buttons T5/T6 to change the setting. The options are:

- **0 = VoLt:** Analog outputs are voltage type (0-10V). This selection is the default.
- **1 = CUrr:** Analog outputs are current type (4-20mA).

This setting applies to Actual Spraying Current and Actual Spraying Voltage analog outputs for the discrete I/O interface. See [Discrete I/O, page 21](#), for more information.



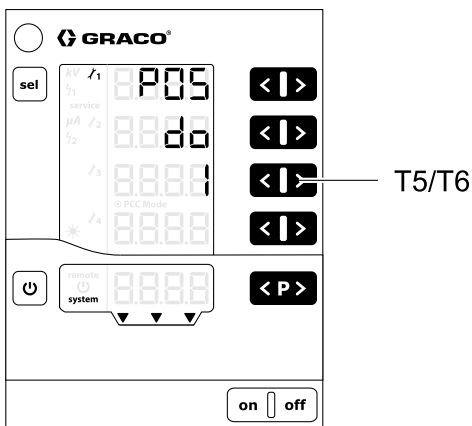
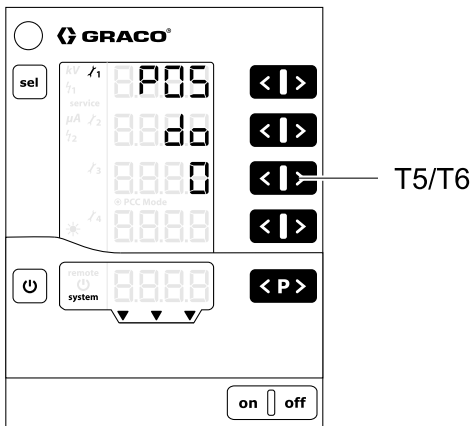
Setup Screen 5 (Digital Output Type Select)

Use Setup Screen 5 (Parameter P05) to select the output signal type for the discrete I/O interface digital outputs (do). Press buttons T5/T6 to change the setting. The options are:

- **0 =** : Digital outputs are sinking type (negative logic). This selection is the default.
- **1 =** : Digital outputs are sourcing type (positive logic).

This setting applies to the Safe-to-Move Output, the Error Output, and the Electrostatic Discharge Output pins on the Discrete I/O Interface. See [Discrete I/O, page 21](#), for more information.

NOTE: The controller must be restarted for a change to this parameter to take effect.

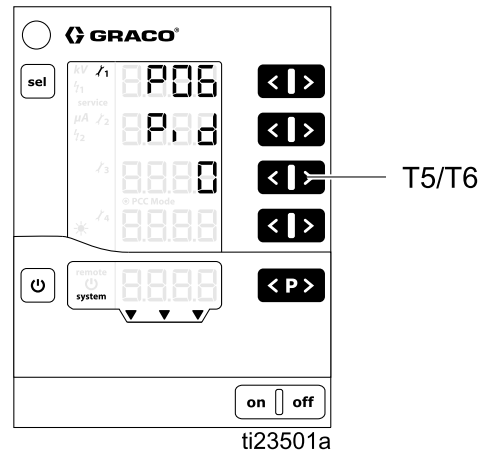


Setup Screen 6 (CAN Purpose ID)

Use Setup Screen 6 (Parameter P06) to select the CAN purpose ID of the controller. For systems with one applicator, set the value to 0 (default). For a system with many applicators, set the CAN purpose IDs to match each applicator number. For example:

- 0 = applicator 1
- 1 = applicator 2

NOTE: The controller must be restarted for a change to this parameter to take effect.



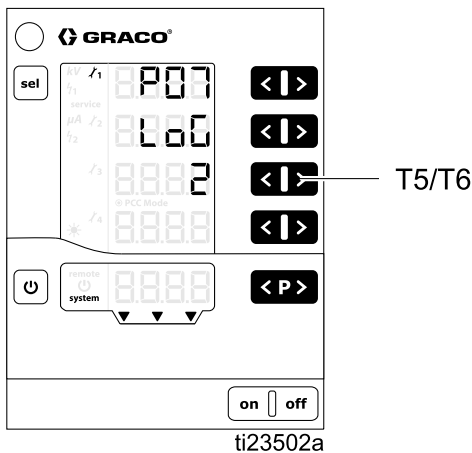
Setup Screen 7 (Log Level)

Use Setup Screen 7 (Parameter P07) to select the log level (LoG) for how much information is logged in the system (used for troubleshooting only). Press buttons T5/T6 to change the setting. A setting of 0 means nothing is logged. A setting of 4 means everything is logged. The default is zero (0).

NOTE: For logging, a micro SD card must be inserted in the slot found on the main circuit board. If a software update has been done by installing a micro SD card, this card can be used for logging. If no card has been installed, or to verify whether one is present, see [Software Update, page 73](#).

The controller can export log reports of controller activity to an installed micro SD card for test purposes and for finding defects.

NOTE: If a micro SD card is present when the controller is turned on, the log messages are recorded in a file (MESSAGES.LOG) located in the root directory. When the file size reaches 32 MB, it is renamed MESSAGES.1 and a new MESSAGES.LOG file is created. Subsequent log file names will be sequentially numbered.

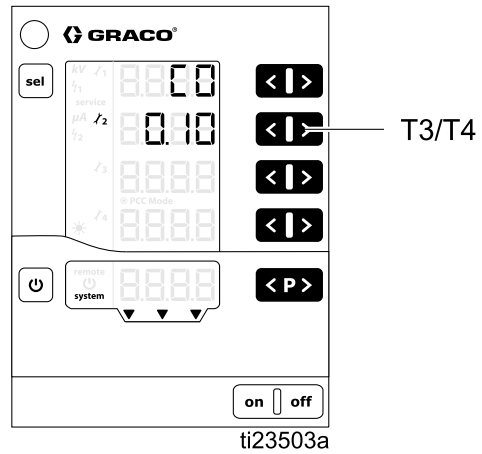


Setup Screen 8 (Averaging Interval)

Use Setup Screen 8 (Configuration C0) to select the averaging interval (in seconds) used to calculate the dynamic arc. Press buttons T3/T4 to change the setting. The default is sufficient for most applications.

See [Arc Detection, page 55](#) for more information.

- Range is 0.01 – 0.5 by 0.01
- Default 0.10 (shown)



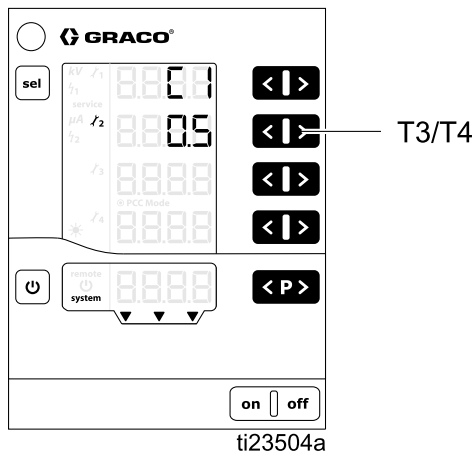
Setup Screen 9 (Blanking Time)

The Electrostatic Controller uses a fixed blanking time which is defined by this screen. The blanking time is the time between when electrostatics are activated and Arc Detection is enabled. Adjust the Blanking time duration to ensure that the system reaches full voltage during the Blanking time. If arc detection errors occur when the electrostatics are activated, increase the Blanking time or adjust the arc detection parameters to be less sensitive, as defined in [Run Screen 2 \(Arc Limits\)](#), page 53 and [Arc Detection](#), page 55.

Use Setup Screen 9 (Configuration C1) to select the time (in seconds) for which arc detection is disabled (blanking time) after electrostatics are activated. This setting controls the time from when the electrostatics are enabled until arc detection is enabled. Press buttons T3/T4 to change the setting.

See [Arc Detection](#), page 55 for more information.

- Range is 0.0 – 30.0 by 0.1
- Solventborne Default is 0.5 (shown)
- Waterborne Default is 10.0 (not shown)



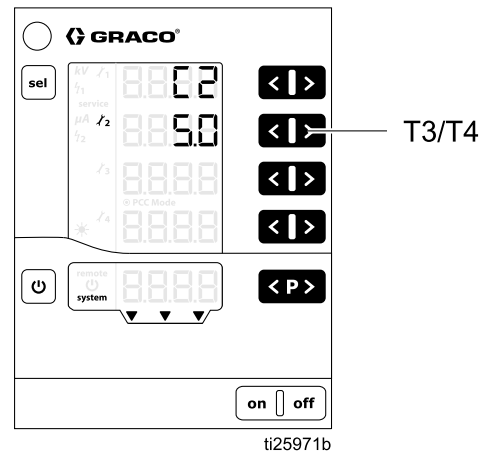
Setup Screen 10 (Discharge Timer)

Use Setup Screen 10 (Configuration C2) to select the time (in seconds) from when the electrostatics are disabled until the electrostatics discharged output signal is active. Press buttons T3/T4 to change the setting.

Use the following procedure to set the discharge timer to a value that will ensure that the system has been discharged.

1. Start with the discharge timer set at the default value of 5 seconds (solventborne systems) or 30 seconds (waterborne systems).
2. Verify that the system discharges within this time using the Voltage Discharge and Grounding Procedure in ProBell manual 334452 or 334626.
3. If the system is not fully discharged during the time allowed, increase the discharge using button T4. Repeat Step 2.
4. To check whether your system will discharge fully in a shorter time, use button T3 to decrease the discharge time. Repeat Step 2.

- Range is 5.0 – 120.0 by 0.1
- Solventborne Default is 5.0 (shown when artwork is updated)
- Waterborne Default is 60.0 (not shown)



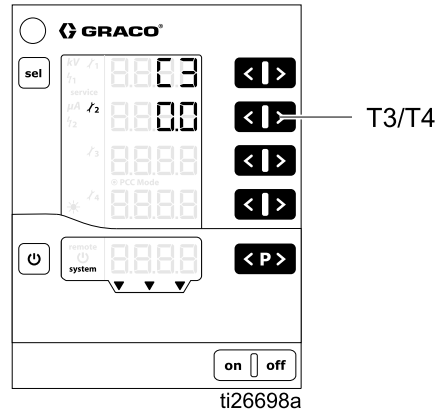
NOTE: The Electrostatics Discharged output indicates when the discharge time has passed. See [Discrete I/O](#), page 21.

Setup Screen 11 (Transition Time)

The transition time is the time over which the controller changes the electrostatics. The transition time applies when electrostatics are enabled and when the Voltage Setpoint is changed. Arc detection remains active when the voltage setpoint is changed. If arc detection errors occur when the voltage (or current) setpoint is changed, increase the transition time or adjust the Arc Detection parameters to be less sensitive (see [Arc Detection, page 55](#)).

Use Setup Screen 11 (Configuration C3) to set the interval of transition time (in seconds) for the electrostatic output. This setting will help eliminate nuisance arc detection errors during transition time. Press T3/T4 to change the setting.


- Range is 0.0 – 5.0 sec
- Default is 0.0 (shown)



Operation

System Start-up

Press **on** to turn on the controller. The controller always starts up to the last configured settings. The controller has two sets of screens, Run and Setup. This section includes information on the Run screens, used to operate the electrostatic applicator. See [Setup Screens, page 42](#), If you have not yet completed initial setup.

Press and hold  to toggle between the Run screens and the Setup screens.

NOTE: When viewing Run Screens, after 5 seconds have elapsed since the last keystroke, the display will revert to Run Screen 1.

Presets



The Electrostatic Controller has 251 (P000-P250) user-defined Presets. There are four values associated with each Preset. These are:

- Voltage setpoint
- Current setpoint
- Static arc limit
- Dynamic arc limit





Voltage and current setpoints are specified on [Run Screen 1 \(Electrostatic Readings\), page 52](#). Arc limits are specified on [Run Screen 2 \(Arc Limits\), page 53](#).

NOTE: Only Presets P000-P003 are accessible through the discrete I/O interface. The CAN interface runs in preset P000 only. All Presets (P000-P250) are accessible in local mode.

Run Screen 1 (Electrostatic Readings)


				
<p>To reduce the risk of electric shock, do not use the Electrostatic Controller readings to determine if your system is discharged. The controller will only display the voltage while the applicator's power supply is operating. Follow the Fluid Voltage Discharge and Grounding Procedure described in the applicator manual.</p>				

Run Screen 1 is the main screen for the electrostatic applicator. This screen shows the active preset (A5) and setpoints for voltage (A1) and current (A2). The screen also displays actual values for kV and μA when the electrostatics are active/triggered. Actual values are displayed in green.

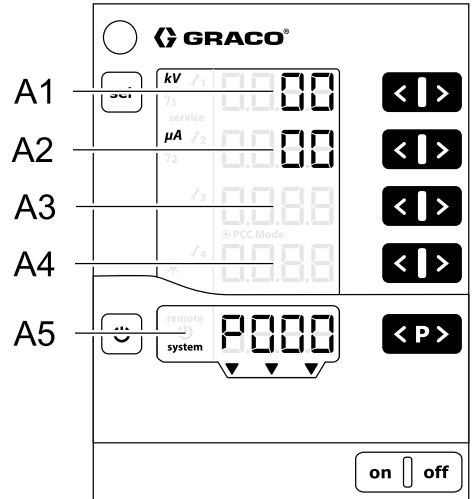
Use this screen to set the voltage (A1) and current (A2) setpoints for each Preset. The setpoint is displayed in black. Setpoints can be changed by pressing the corresponding  and  keys when actual values are displayed. The setpoints also can be viewed by pressing  or  once.

NOTE: When in REMOTE operation, these values cannot be changed using the display keys.

NOTE: If either the voltage setpoint (A1) or the current setpoint (A2) are set to zero, the electrostatics will not turn on even if electrostatics are enabled.

Press  to select the Preset (P000 — P250).

Press  to acknowledge error codes.



ti23486a

Location	Description	Units	Range	Default
A1	Black: Voltage Setpoint Green: Spraying Voltage	kV	0–100kV (solventborne) 0–60kV (waterborne)	0kV
A2	Black: Current Setpoint Green: Spraying Current	μA	0–150 μA	0 μA
A3–A4	None	—	—	—
A5	Active Preset, error diagnosis, or status	—	—	—

Run Screen 2 (Arc Limits)

Run Screen 2 is the secondary screen for the electrostatic applicator. This screen shows the active Preset, arc detection limits, and screen backlight brightness. Screen backlight brightness is set 0–8, with zero being Off and 8 being the brightest. **NOTE:** The screen will dim automatically after 5 minutes of inactivity. The screen backlight brightness is not reset if factory defaults are restored.

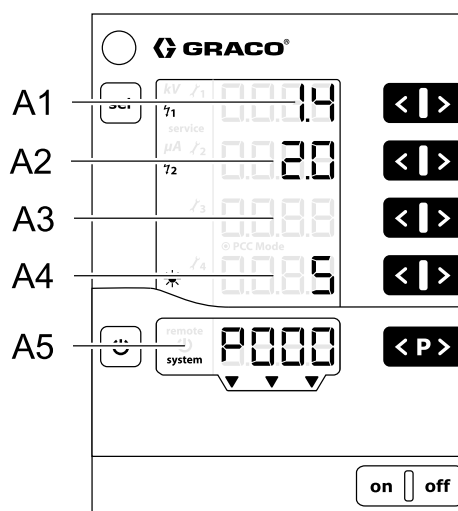
Arc detection is a safety feature of the Electrostatic Controller. Arc detection is used to detect when grounded objects are too close to the electrostatic spraying device. If this occurs, the controller shuts down electrostatic generation instead of creating an electrical discharge.

The static arc limit is used to detect a grounded object that is stationary or slow moving. The dynamic arc limit is used to detect grounded object that is fast moving. For both static and dynamic arc limits, lower values are more sensitive than higher values.

See [Arc Detection, page 55](#), for more information.

NOTE: It is recommended that arc detection settings not be changed from defaults. Any desired change must be set individually for every Preset.

The setpoints are locked. To change the setpoints, press and hold both of the T1/T2 or both of the T3/T4 arrows simultaneously. The setpoint numbers will turn red. Use arrows T1 and T2 to change the static arc limit. Use arrows T3 and T4 to change the dynamic arc limit. Arc detection parameters relock after 4 seconds or when the screen is exited.



ti23487b

Location	Description	Range	Default
A1	Static Arc Limit	0.1–2 nS	1.4 nS
A2	Dynamic Arc Limit	0.1–4 nS/s	2.0 nS/s
A3	None	—	—
A4	Screen Backlight Brightness	0–8	5
A5	Active Preset, error diagnosis, or status	—	—





Run Screen 3 (Maintenance Counters)



Run Screen 3 is the maintenance screen. This screen shows the four maintenance counters and the non-resettable trigger counter.

When dashes are shown in the maintenance counters, monitoring is deactivated. When numbers are shown, the maintenance counters show days of remaining service life.

NOTE: Maintenance counters are activated only when electrostatics are active/triggered.

NOTE: The trigger counter shows an amount of time (in days) that electrostatics have been activated for the connected power supply. It cannot be cleared. Each tenth equates to 2.4 hours of elapsed time.

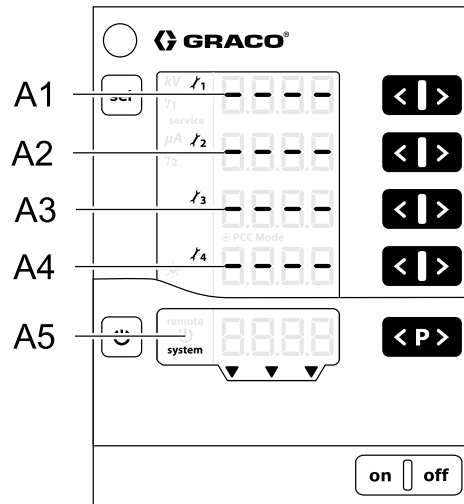
To activate monitoring: press the corresponding  and  simultaneously for a deactivated counter. During the first activation a value of 1 is shown as the start value. If monitoring has already been activated at some earlier point, then the last stored value is displayed. Set the desired service life for each wearing part using the  and .

To deactivate monitoring: press the corresponding  and  simultaneously for an active counter.

If the selected service life is exceeded, the maintenance counter will be shown as a negative

number. The **service** symbol also will appear. Controller operations are not stopped.

NOTE: Maintenance counters, states (active/inactive), and setpoints are not reset when factory defaults are restored.



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Designation	Function	Units	Range
A1–A4	Maintenance counter 1–4	days	0.1–500
A5	Trigger counter, error diagnosis, or status	days	—

Arc Detection

The primary method to prevent arcing to the workpiece is to keep the charged components of the applicator at least 6 in. (15.2 cm) away from the workpiece at all times. In addition, the Electrostatic Controller is equipped with a feature called arc detection. When the controller detects conditions suitable to create an arc, the arc detection circuitry disables the power supply drive circuitry and produces an arc detection error. The power supply drive circuitry remains disabled until the error has been confirmed by the user or the PLC.

The arc detection circuitry helps minimize the risk of arcing, but a 6 in. (15.2 cm) minimum safe distance must be maintained at all times.

Check Arc Detection Function

				
<p>To avoid fire or explosion during the test, all spraying devices in the hazardous area must be turned off and ventilation fans in the hazardous area must be operating. Conduct the test only when no flammable vapors are present in the area (such as open solvent containers or fumes from spraying).</p>				

To verify the proper operation of the arc detection follow the test procedure from EN standard 50176. The test must be conducted after all system parameters have been set but before operation. The arc detection test should be repeated periodically and any time the system parameters are changed. Repeat yearly at a minimum. The test verifies that the arc detection is functioning correctly, so the equipment detects the possibility of a static arc and the electrostatics turn off before any spark is discharged. An error code of H15, H16, H17, or H18 should display. An example method of testing is provided in the next two sections, first for stationary/reciprocator systems and then for robot-mounted systems.

For Stationary Systems and Reciprocators

Follow the general procedure for robot-mounted systems (next section), but manually approach the stationary cup with a grounded plate or rod at a speed that simulates production conditions.



For Robot-Mounted Systems

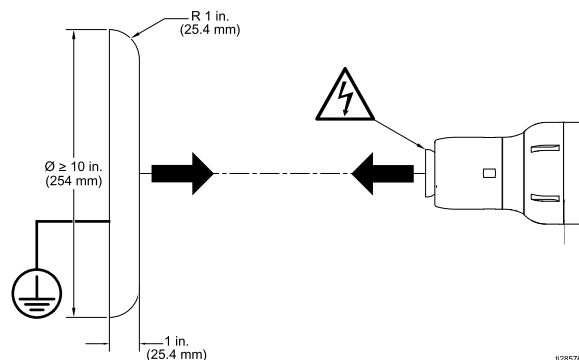
The test can be conducted with Grounded Test Plate Kit 25C424, purchased separately. Users

also may supply a grounded plate that meets the requirements specified in the illustration. The test must be conducted with no fluid in the applicator and the shaping airs off.

1. Record the temperature, relative humidity, and air pressure in the operating environment.
2. Position the test plate so that it is aligned at the center with the cup. See illustration.
3. Connect the test plate to a true earth ground.
4. Set the starting distance between the test plate and the cup electrode to 0.5 cm/kV of the set output voltage of your system. For example, if your output voltage is set to 50 kV, the plate and the cup must be placed at least 25 cm (10 in.) apart.
5. Set the approach speed of the robot so that it is 1.2 times the maximum movement speed of the robot during spraying operation, at least 500 mm/second.
6. Activate the electrostatics and approach the grounded target to within 1 cm.
7. Perform the test five times. Each time, the electrostatics must turn off before any visible spark occurs between the electrodes.
8. Increase or decrease the sensitivity of the arc detection settings as needed to pass the test. See [Arc Detection Adjustments, page 56](#).



A 6 in. (15.2 cm) minimum safe distance must still be maintained during spraying operations.

				
<p>To avoid fire and explosion, the correct operation of the arc detection function must be tested periodically. The test must be repeated every 6 months and anytime the system parameters are changed.</p>				



Arc Detection Adjustments

The following parameters can be changed to influence the arc detection performance.

Setting	Remarks
Static Arc Limit *  View or change on Run Screen 2 (Arc Limits) , page 53, Location A1	Range: 0.1–2 nS Set the value lower to increase sensitivity and to deactivate the electrostatics sooner as a grounded object approaches the applicator. Set the value higher to decrease sensitivity and to eliminate nuisance errors. This value is most useful for slow-moving targets.
Dynamic Arc Limit *  View or change on Run Screen 2 (Arc Limits) , page 53, Location A2	Range: 0.1–4 nS/s Set the value lower to increase sensitivity and to deactivate the electrostatics sooner if a grounded object is approaching the applicator at too high a speed. Set the value higher to decrease sensitivity and to eliminate nuisance errors.
Voltage Setpoint* View or change on Run Screen 2 (Arc Limits) , page 53, Location A1	Range: 0–100kV (solventborne) or 0–60kV (waterborne) Decrease the voltage if changes to the static and dynamic limits are not sensitive enough.
Averaging Interval View or change on Setup Screen 8 (Averaging Interval) , page 48, Configuration C0	Range: 0.01–0.5 s by 0.01 Valid for all Presets. Set the averaging interval to make the Dynamic Arc Limit more sensitive. Lowering this setting adds to the sensitivity achieved by setting the Dynamic Arc Limit itself. The default averaging threshold is adequate for most applications. If nuisance errors are seen when triggering or detraggering fluid, increase this parameter.
Blanking Time View or change on Setup Screen 9 (Blanking Time) , page 49, Configuration C1	Range: 0.0–30.0 s by 0.1 Valid for all Presets. Arc detection is suppressed from when electrostatics are activated until the blanking time has elapsed. Adjust the setting to ensure the system reaches full voltage during the blanking time. If arc detection errors occur when the electrostatics are activated, increase the blanking time. Decrease the blanking time for greater sensitivity. Arc detection is deactivated during the blanking time. <ul style="list-style-type: none"> • Activate the electrostatics only when the applicator is in SAFE POSITION. • Do not move the applicator out of the SAFE POSITION before the blanking time has elapsed and arc detection is active. Use interlocking signals between the controller and the device performing the applicator's motion control. See Safe Position Mode , page 31 for more information.
Transition Time View or change on Setup Screen 11 (Transition Time) , page 50, Configuration C3	Range: 0.0–5.0 s by 0.1 Valid for all Presets. Increase the transition time if arc detection errors occur when the voltage (or current) setpoint is changed. This setting helps eliminate nuisance arc detection errors during transition time.

* Must be set for each Preset.

Live Arc Detection Values

Press and hold the SEL button from Run Screen 1. The screen will change to Run Screen 2 when the button is pressed. Continue holding until the screen changes to Run Screen 3. Press the SEL button one more time to return to Run Screen 1. There should now be two additional numbers shown on the Screen.

On Run Screen 1, the top number is kV, the second number is uA, the third number is the live value for static arc detection, and the bottom number is the live value for dynamic arc detection.

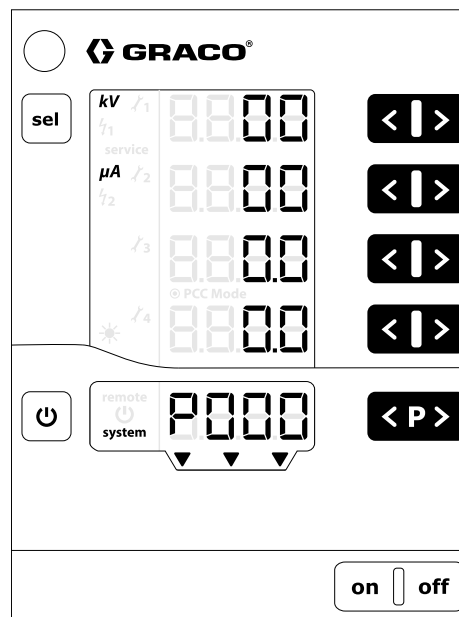
During normal operation, the live arc detection values should be below the arc detection limits set on Run Screen 2. An arc detection error occurs when the live arc detection value exceeds arc detection limit setpoint. When an arc detection error occurs, the live arc detection values freeze on the screen. This will tell you what the maximum arc detection values were when the error occurred and will help to set the arc detection limits properly.

Watch the live static and dynamic arc values during normal operation. Set your static and dynamic arc detection limits slightly higher than the largest numbers seen on the screen.

If you are still experiencing a lot of nuisance arc detection errors, watch the static and dynamic arc values during a situation where a nuisance arc detection error occurs. (This is a situation where an arc detection error should not occur, but creates





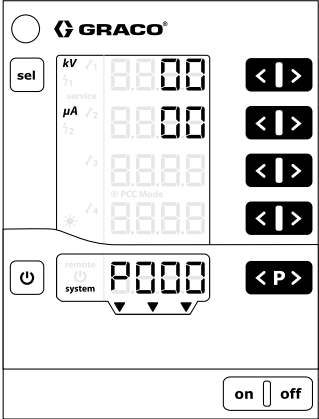
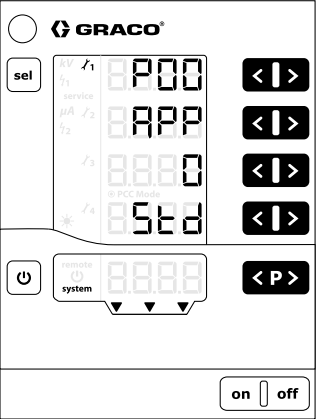
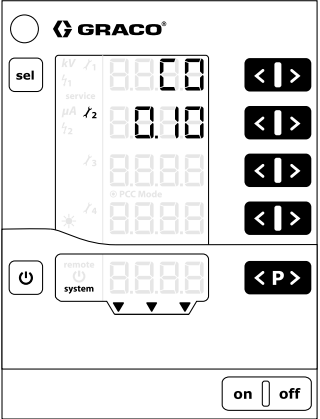



an error anyway.) Set your static and dynamic arc detection limits above the largest numbers seen on the screen.

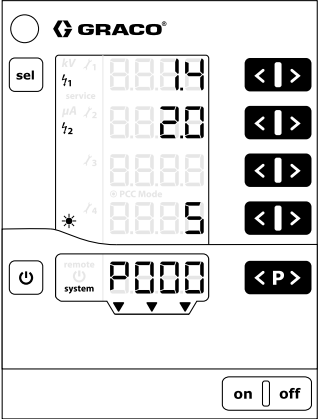
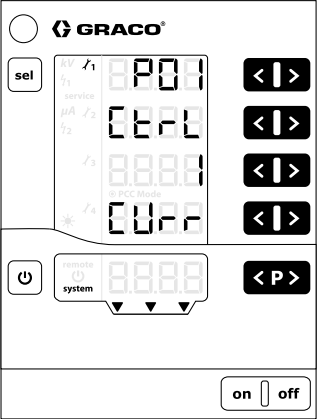
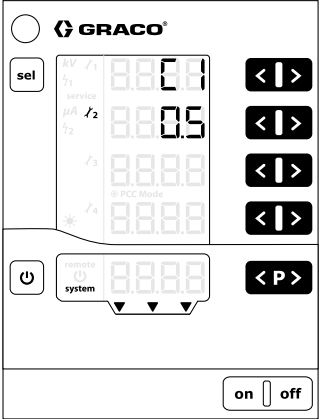
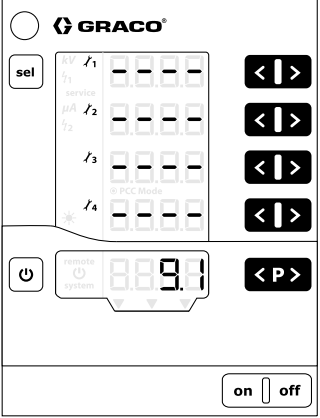
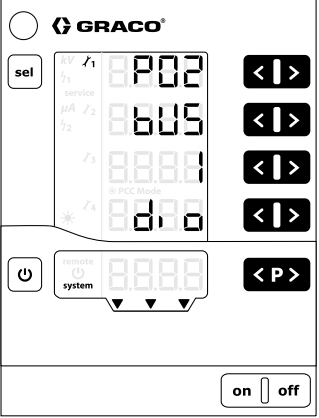
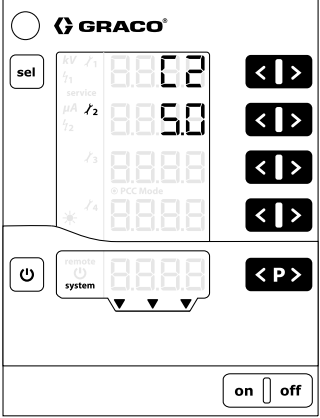

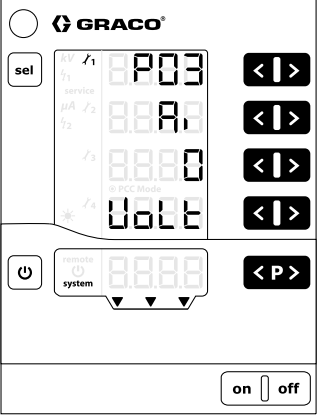
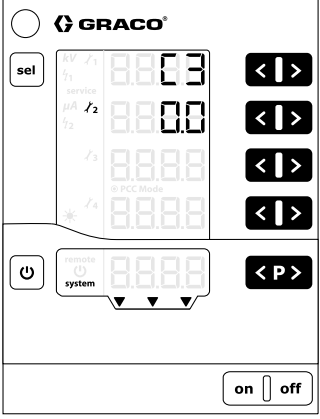
NOTE: The live arc detection values must be enabled again if the controller loses power.

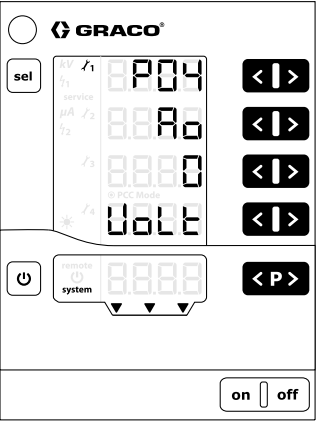
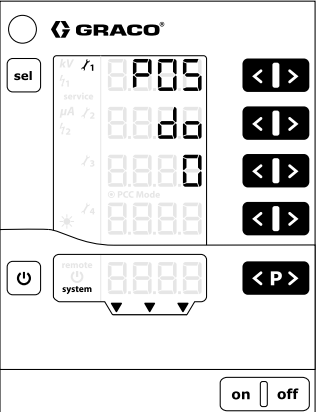
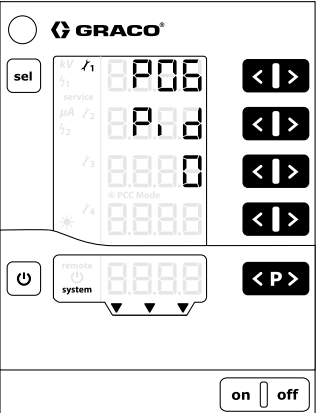


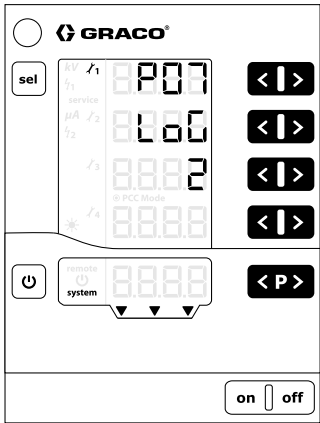
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Screen Map

<p>RUN</p> <p>Press and hold  for 5 seconds from any SETUP screen. Also shown on power up.</p>	<p>SETUP SCREENS 0-7 (Parameters)</p> <p>Press and hold  for 5 seconds from any RUN screen. Or, press  from SETUP SCREENS 8-11. Screens that are not implemented for the Electrostatic Controller are not shown.</p>	<p>SETUP SCREENS 8-11 (Configurations)</p> <p>Press  from SETUP SCREENS 0-7.</p>
	<p>Solventborne or Waterborne</p> 	
	 T1/T2	 T1/T2

RUN	SETUP SCREENS 0-7 (Parameters)	SETUP SCREENS 8-11 (Configurations)
		
<p style="text-align: center;">sel</p>	<p style="text-align: center;">← T1/T2</p>	<p style="text-align: center;">← T1/T2</p>
		
<p style="text-align: center;">sel</p>	<p style="text-align: center;">← T1/T2</p>	<p style="text-align: center;">← T1/T2</p>
		
	<p style="text-align: center;">← T1/T2</p>	<p style="text-align: center;">← T1/T2</p>

RUN	SETUP SCREENS 0-7 (Parameters)	SETUP SCREENS 8-11 (Configurations)
		
	<p style="text-align: center;">◀ T1/T2</p>	
		
	<p style="text-align: center;">◀ T1/T2</p>	
		
<p style="text-align: center;">◀ T1/T2</p>		

RUN	SETUP SCREENS 0-7 (Parameters)	SETUP SCREENS 8-11 (Configurations)
	 <p style="text-align: center;"> ◀ T1/T2 </p>	

Troubleshooting

Error Codes

The Electrostatic Controller is monitored constantly. If a error is detected, an error message is indicated with a error code.

The error codes are shown in red on the **A5** display.



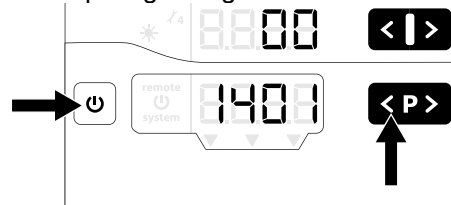
The four most recent error codes are stored by the order of their appearance. Each error in the list must be acknowledged with the **<P>** key. If an error code is shown, the **<P>** key cannot be used for other functions

The following table shows all possible error codes for the Electrostatic Controller.

Reason Codes

In addition to the error message, some error codes (such as H81) have additional information displayed as a reason code. When an error code is shown

on the A5 display, press the **⏻** key and the **<P>** button at the same time to view the four-digit reason code. This reason code displays as long as the keys are held. If pressing these buttons does not show a four-digit reason code, the error code does not have a reason code. Contact Graco Technical Assistance for help diagnosing a reason code.



Code	Description	Criteria	Controller Action	Solution
Electrostatics				
H11	Applicator failure	The controller does not detect a current from the applicator, or detects a current that is too low.	Stop	<ul style="list-style-type: none"> Verify the applicator power cable connection, perform power cable continuity (see Power Cable Continuity, page 66), and replace the cable if needed. Replace the applicator power cable or applicator power supply if needed.
Reason Code: 0001				
	Applicator failure	The controller detects a current that is too high.	Stop	<ul style="list-style-type: none"> Replace applicator power supply.
Reason Code: 0002				
	Applicator failure	The controller detects a high applicator temperature.	Stop	<ul style="list-style-type: none"> Replace applicator power supply.
Reason Code: 0003				
	Applicator failure	The controller detects a high applicator input voltage.	Stop	<ul style="list-style-type: none"> Replace applicator power supply.
Reason Code: 0004				

Code	Description	Criteria	Controller Action	Solution
H12	Spraying current offset high	The controller has detected a high off-state current. This error can occur during normal operation in waterborne systems during discharge or when multiple applicators are connected to the same fluid supply.	Stop	<ul style="list-style-type: none"> • Verify the applicator power cable connection, perform power cable continuity (see Power Cable Continuity, page 66), and replace the cable if needed. • Replace the applicator power cable if needed. • Verify all connections inside the controller. • Replace the main board if needed. • Verify system grounding.
H13	Applicator supply overvoltage	Applicator voltage is too high.	Stop	<ul style="list-style-type: none"> • Verify the applicator power cable connection, perform power cable continuity (see Power Cable Continuity, page 66), and replace the cable if needed. • Replace the applicator power cable or applicator power supply if needed.
H14	Spraying current ground fault	The controller has detected a short between the chassis and the ground.	Stop	<ul style="list-style-type: none"> • Verify the applicator power cable connection, perform power cable continuity (see Power Cable Continuity, page 66), and replace the cable if needed. • Replace the applicator power cable if needed. • Verify all connections inside the controller. • Replace the main board if needed.
H15	Arc detection static limit	The static arc detection threshold is exceeded. A grounded object came too close to the applicator.	Stop	<ul style="list-style-type: none"> • Verify closest distances to parts. • Verify paint conductivity. • Verify spraying parameters associated with static arc detection. See Run Screen 2 (Arc Limits), page 53.
H16	Arc detection dynamic limit	Dynamic arc detection threshold exceeded. A grounded object approached the applicator at too high of a speed.	Stop	<ul style="list-style-type: none"> • Verify fastest approach to parts. • Verify paint conductivity. • Verify spraying parameters associated with dynamic arc detection. See Run Screen 2 (Arc Limits), page 53.
H17	Arc detection both limits	A grounded object came too close to the applicator at too high of a speed.	Stop	<ul style="list-style-type: none"> • Verify closest distances to parts. • Verify fastest approach to parts.
H18	Arc detection unspecified	Arc detection triggered due to unspecified reason.	Stop	<ul style="list-style-type: none"> • Verify paint conductivity.
H19	Arc detection drive voltage	Power supply drive voltage rose too quickly.	Stop	<ul style="list-style-type: none"> • Verify spraying parameters associated with arc detection. See Run Screen 2 (Arc Limits), page 53.

Code	Description	Criteria	Controller Action	Solution
H91	Power Supply Communication Error	Communication between controller and power supply failed	Stop	<ul style="list-style-type: none"> Verify the applicator power cable connection, perform power cable continuity (see Power Cable Continuity, page 66), and replace the cable if needed. Replace applicator power cable or applicator power supply if needed.
Internal Controller Errors				
H20	Controller mainboard voltage tolerance	Onboard generated voltage is out of tolerance	None	<ul style="list-style-type: none"> Verify all connections inside of controller are properly made. Verify power source is good.
H21	Controller mainboard voltage failure	24V supply drops below 21V. Remark: No error code is displayed, only logged.	Shutdown	<ul style="list-style-type: none"> Replace 24 VDC board or power board if necessary.
H24	Memory contents invalid	Magic number doesn't match expected value	Initialize defaults	<ul style="list-style-type: none"> Verify all connections inside of controller are properly made.
H25	Memory write timeout	Writing to EEPROM takes longer than 10ms	None	<ul style="list-style-type: none"> Replace main board if necessary.
H26	Memory shutdown error	Data to be written at power off hasn't been properly saved to the EEPROM	None	<ul style="list-style-type: none"> Do not turn off controller so quickly after making setting changes. Verify all connections inside of controller are properly made. Replace main board if necessary.
H27	Memory verify failure	Verification of the data written to the EEPROM failed	None	<ul style="list-style-type: none"> Verify all connections inside of controller are properly made. Replace main board if necessary.
H80	Safety controller communication Error	No response/timeout to a request. Error report on command execution. Response data mismatch	Stop	<ul style="list-style-type: none"> Verify all connections inside of controller are properly made. Clear error. If it returns, call for help.
H81	Safety controller self-test failure	The self-test performed by the safety controller detected an error	Stop	<ul style="list-style-type: none"> Replace main board if necessary.
H82	Safety controller not alive	Heartbeat message timeout	Stop	<ul style="list-style-type: none"> Verify all connections inside of controller are properly made. Replace main board if necessary.
H83	24 VDC interlock missing	24 VDC interlock removed while electrostatics in operation	Stop	<ul style="list-style-type: none"> Verify DIO cable connections. Verify connected interlocked devices are functioning. Verify all connections inside of controller are properly made. Replace main board if necessary.
H84	Safety controller update required	The safety controller firmware requires an update	None	<ul style="list-style-type: none"> Verify all connections inside of controller are properly made. Verify software version and update if needed. Replace main board if necessary.

Code	Description	Criteria	Controller Action	Solution
H85	Not in safe position	Attempt to turn on the electrostatics while the applicator isn't in the safe position.	Stop	<ul style="list-style-type: none"> Verify DIO cable connections. Verify connected interlocked devices are functioning. Verify all connections inside of controller are properly made. Replace main board if necessary.
H86	No valid parameters set	Attempt to turn on the electrostatics without valid arc detection parameters set.	Stop	<ul style="list-style-type: none"> Verify all connections inside of controller are properly made. Verify software version and upgrade if needed. Replace main board if necessary.
H87	Send queue overflow	Too many message transmission requests at the same time.	Stop	<ul style="list-style-type: none"> Verify all connections inside of controller are properly made. Replace main board if necessary.
H88	Digital output type not set	An attempt is made to turn on the electrostatics when the digital output type is not configured.	Stop	<ul style="list-style-type: none"> Verify all connections inside of controller are properly made. Verify software version and upgrade if needed.
H90	Bell controller communication error	No response/timeout to a request. Error report on command execution. Response data mismatch	None	<ul style="list-style-type: none"> Replace main board if necessary.
H92	Bell controller not alive	Heartbeat message timeout	Stop	
H94	Bell controller update required.	The applicator controller firmware requests an update.	None	<ul style="list-style-type: none"> Verify the software version and update.
H95	Invalid applicator type detected	The incorrect power supply is connected to the controller	Stop	<ul style="list-style-type: none"> Verify that the power supply is meant to be used with this controller.
Graco CAN Bus Errors				
H40	CAN Bus Off	The CAN controller went to bus off state due to permanent bus error.	Stop	<ul style="list-style-type: none"> Verify that parameter P02 on Setup Screen 2 is set to CAN mode and parameter P06 on Setup Screen 6 is correct.
H41	CAN Error Passive	The CAN controller went to error passive state due to repeated bus errors.	Stop	<ul style="list-style-type: none"> Verify CAN cable connections.
H42	CAN receive overflow	CAN messages are arriving too quickly.	Stop	<ul style="list-style-type: none"> Verify that CAN devices are connected and functioning.
H43	CAN receive FIFO overflow	CAN messages arrive faster than they can be transferred to the receive queue.	Stop	<ul style="list-style-type: none"> Replace CAN board, if necessary.
H44	CAN master not alive	The CAN master has failed to rewrite the Remote Operation Enable DVAR within the required interval	Stop, Leave remote operation	
Other Errors These will be logged, but not likely to be seen on the display due to restart				

Code	Description	Criteria	Controller Action	Solution
H901	Assertion failed	Violation of a mandatory precondition	Restart	<ul style="list-style-type: none"> • Verify that all connections inside of the controller are properly made. • Restart controller. • Verify software version and upgrade if needed. • Replace main board if necessary.
H902	Out of memory	Memory allocation failed	Restart	
H903	Watchdog timeout	Watchdog wasn't serviced timely	Restart	
H904	Stack overflow	A stack overflow has been detected.	Restart	
H905	Hard fault error	The CPU detected a hard fault	Restart	
H999	Other fatal error	Unspecified fatal error	Restart	

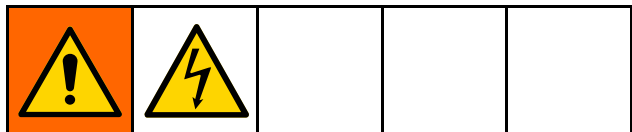
Power Cable Continuity

To ensure that the applicator power cable has not been damaged, it may be necessary to verify the electrical integrity of the cable. To check continuity, perform the following:

1. Power down the system.
2. Remove the applicator power cable.
3. Refer to the cable schematic in [Connections, page 19](#). Use an ohmmeter to check each pin at each connector against all other listed pins to verify continuity where indicated, or isolation between other pins.

Repair

Individual items used in this controller are not repairable. If they fail, they must be replaced. See [Parts, page 74](#), for a list of repair kits.



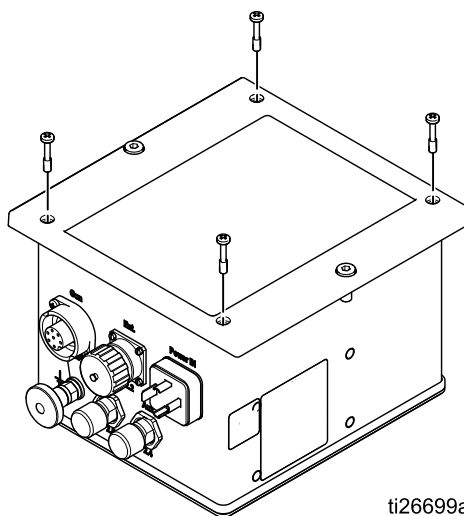
NOTICE

To avoid damaging the circuit boards when servicing the control box, wear Part No. 112190 grounding strap on your wrist and ground appropriately each time

Power Board Fuse Replacement

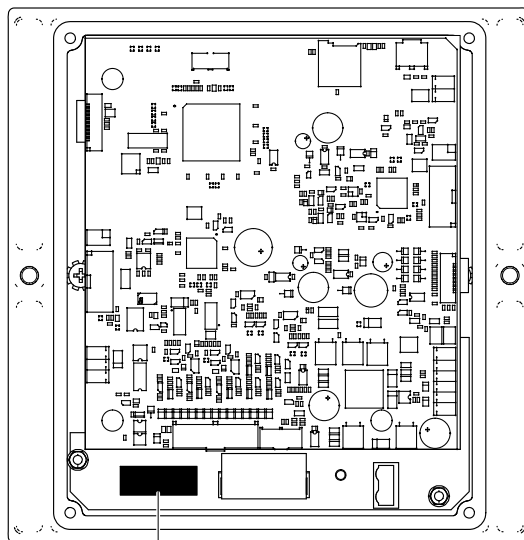


1. Remove power from the system. Follow the appropriate lock-out/tag-out procedures.
2. Using a Phillips head screwdriver, loosen the four screws holding the front access cover in place. Carefully remove the front access cover.



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3. Locate the power board and the fuse F1.



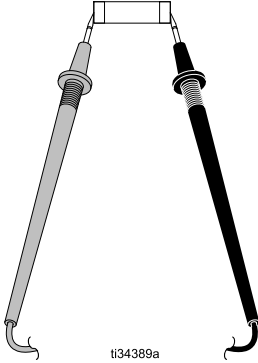
F1

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4. Remove the cover from fuse F1 by gently squeezing the cover lengthwise.

Repair

5. Verify that the fuse is blown. Use a multimeter in Ohms Mode or Conductivity Mode. Place a multimeter lead on either side of the fuse on the metal caps. A blown fuse reads as open. A working fuse reads as <10 Ohms or shorted.



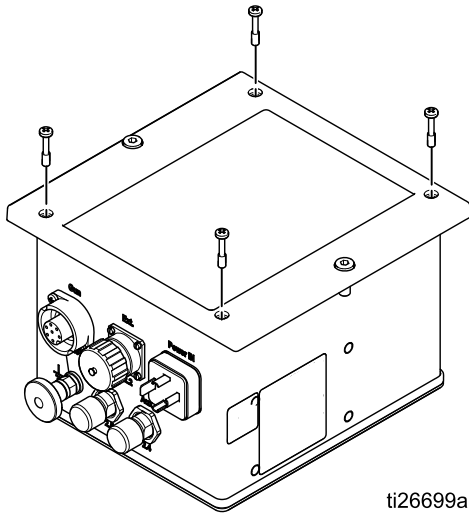
6. If blown, remove the failed fuse F1 from the holder by pulling up on the fuse. Replace the blown fuse with a new fuse of the specified type, current, and voltage rating.

Replacement Fuse Kit	25E312 (Qty 5)
Type	Ceramic 5x20mm Time-Lag T
Current	2A
Voltage Rating	250VAC/300VDC

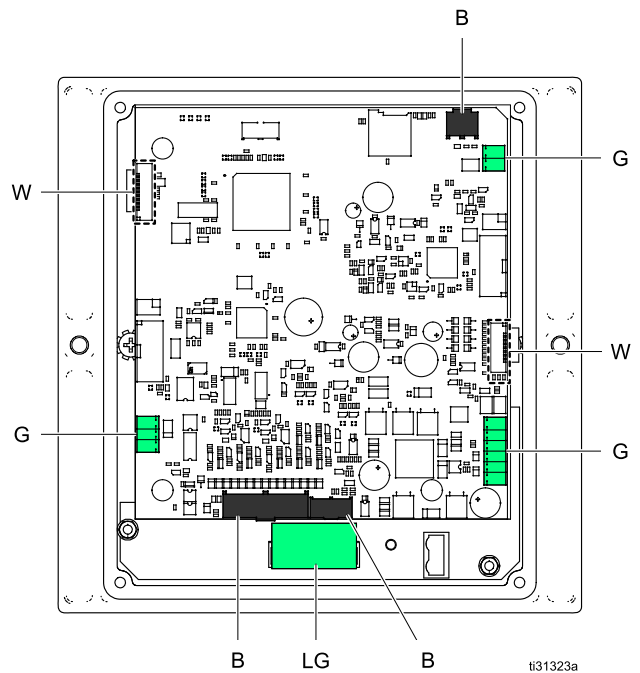
7. Place the fuse cover over the fuse and holder. Press to snap into place.
8. Replace the controller access cover.
9. Screw down the front access cover.
10. Reapply power. Switch on the controller.

Main Circuit Board, Power Board, LED Panel, or Keypad Membrane Removal

1. Remove all outside connections from the controller.
2. Remove the controller from its mounting surface or bracket using the 4 mm (1/8") Allen wrench. NOTE: Service is best accomplished if the controller is on a workbench.
3. Using the Phillips head screwdriver, loosen the four screws holding the front access cover in place. Carefully remove the front access cover.
4. Remove connections on the main board.
 - a. Remove the three green connectors (G). Gently wiggle the connectors from side to side to loosen and remove by hand.
 - b. Unlock the three black connectors (B) using a flat head screwdriver. Gently wiggle the connectors from side to side to loosen and remove by hand.
 - c. Remove the strain relief band from the two white ribbon cables (W). Unlock the ribbon cables by gently wiggling the top of the connector upwards until it snaps out of position. (The connector stays on the board.) Then gently pull the ribbon cable out of the connector.



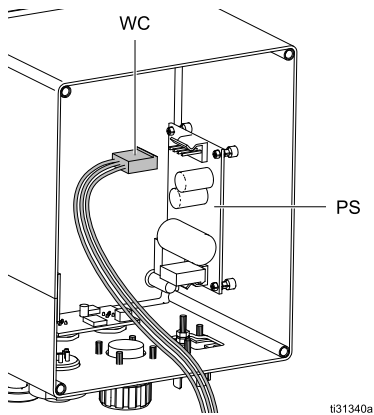
ti26699a



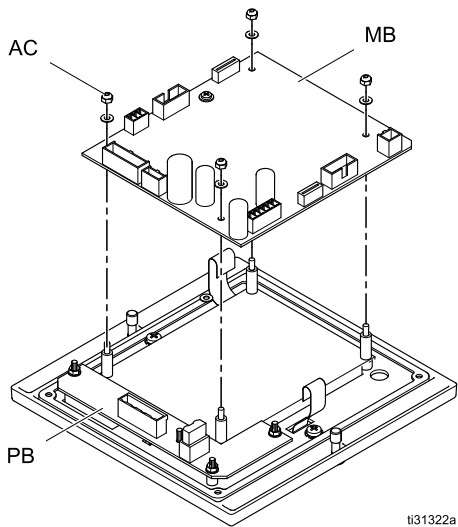
ti31323a

Repair

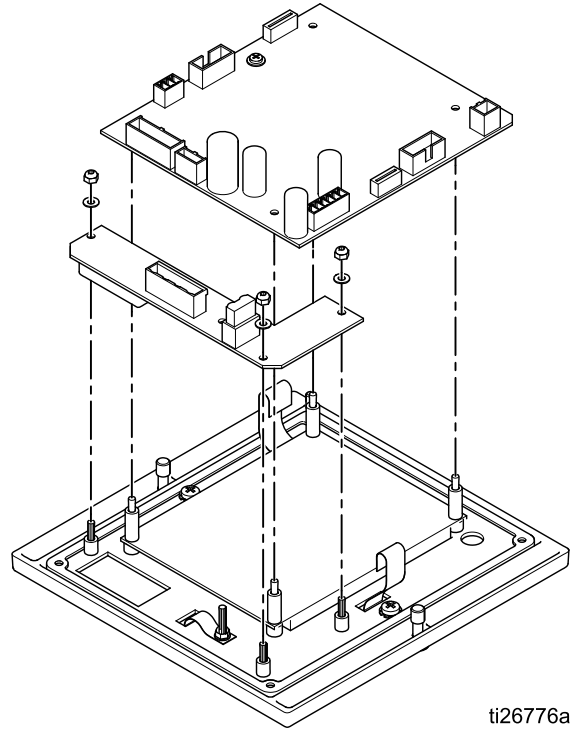
5. For easier service, remove the cable connections to the power board (PB) and power supply board (PS). (The power supply is in the controller housing.)
 - a. Remove the large green connector (LG) on the power board. This is mounted below the main board. Gently wiggle the connector from side to side to loosen and remove by hand.
 - b. Remove the white connector (WC) from inside the controller housing that goes to the power supply. Gently wiggle the connector from side to side to loosen and remove by hand.



6. The main board is held in place by four acorn nuts (AC) and four washers. Using the 5 mm (7/32") socket, remove the nuts and washers and carefully lift the board off the standoffs.

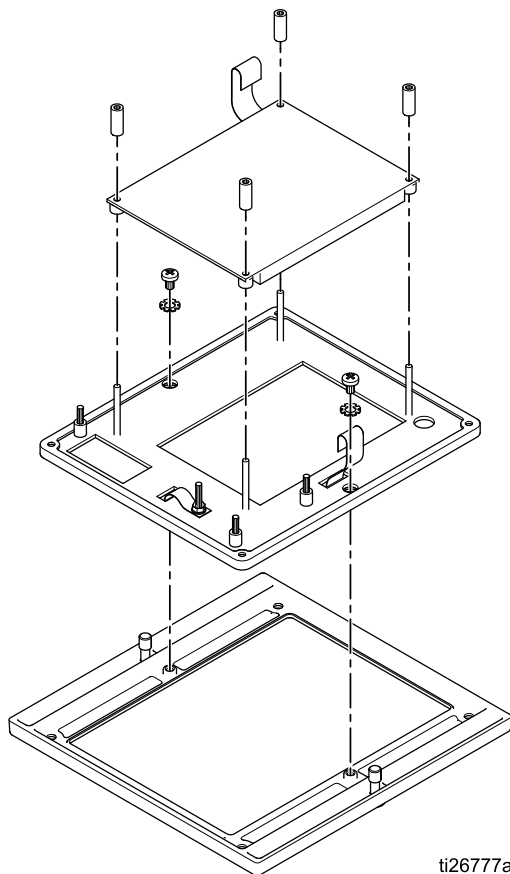


7. The power board is held in place by four acorn nuts (AC) and four washers. If the power board needs to be replaced, using the 5 mm (7/32") socket, remove the nuts and washers and carefully lift the board off the standoffs.



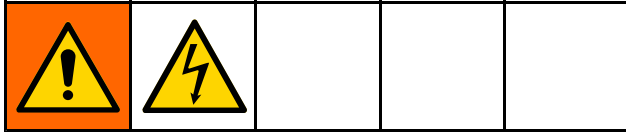
8. If the LCD panel needs to be replaced, remove the four spacers and lift the LCD panel off the standoffs.

9. If the keypad membrane needs to be replaced, remove the two Phillips head screws and lift out the membrane panel.

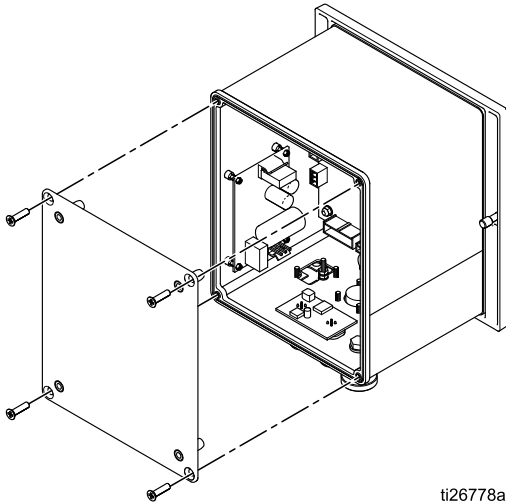


10. If you removed the membrane panel, replace the membrane panel and tighten the two Phillips head screws.
11. If you removed the LCD panel, orient the LCD panel properly and place it on the standoffs. Replace the four spacers on the standoffs.
12. If you removed the power board, orient the power board properly and place it on the standoffs. Replace the washers and acorn nuts on each standoff. Tighten by hand.
13. If you removed the main board, orient the main board properly and place it on the standoffs. Replace the washers and acorn nuts on each standoff. Tighten by hand.
14. If you removed the cable connections, replace the two additional cable connections to the power board (PB) and power supply board (PS).
- Replace the large green (LG) connector on the power board. This is mounted below the main board (MB). Note the keying features and push into place by hand.
 - Replace the white connector (WC) on the power supply board. This is mounted on the inside of the controller housing. Note the keying features and push into place by hand.
15. Replace connections on the main board.
- Replace the three main board green connections (G). Note the keying features and push into place by hand.
 - Replace the three main board black connections (B). Note the keying features and push into place by hand.
 - Replace the two main board white ribbon connections (W). Make sure the top of the connector is loose by gently pulling upwards on the connector.
 - Push the ribbon cable into the connector until it bottoms out.
 - Push the top of the connector down onto the board until it locks.
 - Replace the strain relief band over the ribbon cable and connector.
 - Verify the ribbon cable is locked in place by gently pulling on it.
16. When all connections are made, gently replace the front access cover on the connector housing. Make sure that no cables are pinched in the process.
17. Using the Phillips head screwdriver, tighten the four screws holding the front access cover in place.
18. Replace the outside connections to the controller. Connect the power, turn on the controller, and reload settings before returning to service.

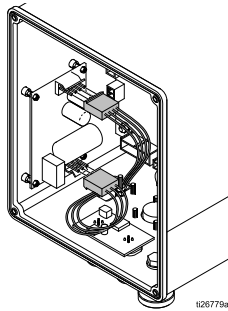
Power Supply Board Removal



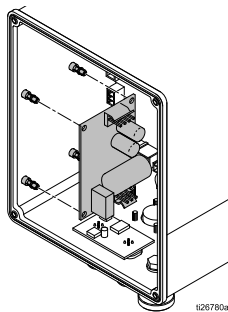
1. Remove power from the system.
2. Remove four screws, then remove the back access panel.



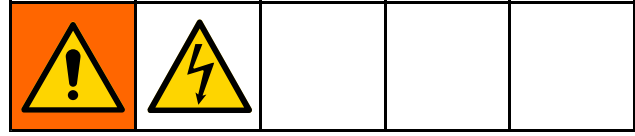
3. Remove the two electrical connectors from the power board, as shown.



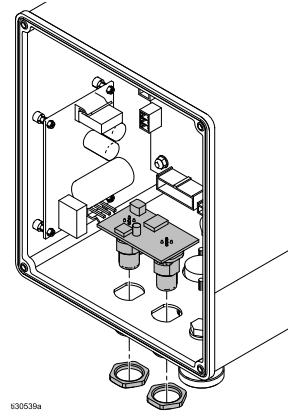
4. Gently pry the power board from the four retaining clips and remove the board, as shown.



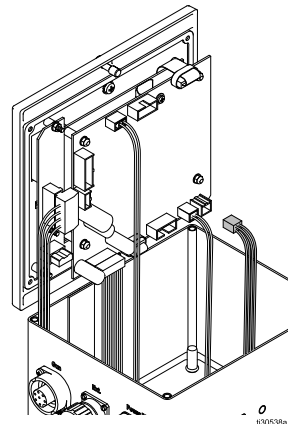
CAN Board Removal



1. Remove power from the system.
2. Remove four screws, then remove the controller access cover.

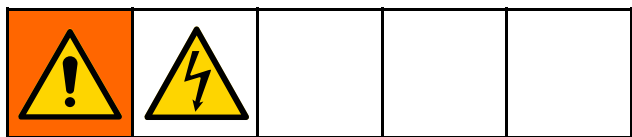


3. Disconnect the CAN connection with a screwdriver.



4. Remove nuts on the CAN connections on the bottom of the controller.
5. Press on CAN connectors to gently remove the CAN board.

Software Update



NOTE: Prior to beginning a software update, make a written copy of Preset settings that have been defined for use with the specific materials being applied with this system. This will ensure that the information is recoverable in the event the software update resets Presets to factory settings.

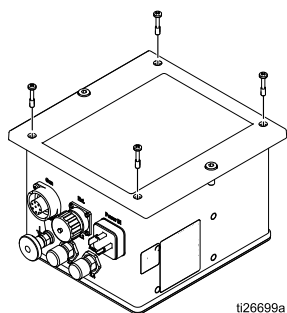
1. Obtain the software update files, (17J278.zip). Unzip the file. There may be one or more files required for the update. Put all files in the root directory of a microSD card.

NOTE: If a microSD card is already in the main board, this step will need to be performed after step 4.

NOTE: There are limitations to the memory size of the microSD card that can be supported.

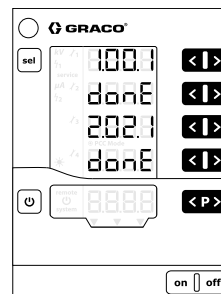
Type	Maximum
SD	2 GB
SDHC	32 GB
Do not use SDXC cards unless they are formatted to FAT32 file format.	

2. Switch off the Electrostatic Controller and remove power from the system.
3. Remove four screws, then remove the controller access cover.

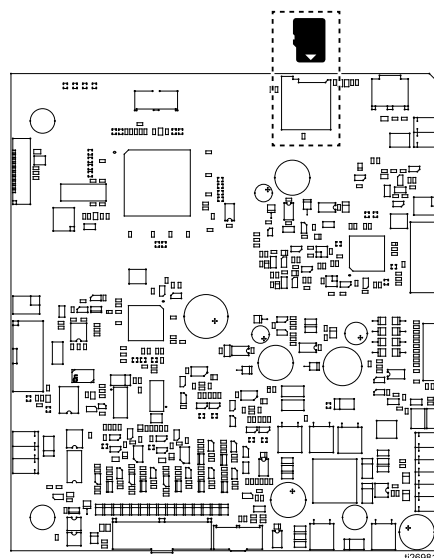


4. Find the micro SD card slot on the top of the main board, and insert the microSD card with the software update.
5. Carefully place the controller access cover onto the controller box. Do not screw down.

6. Apply power to the Electrostatic Controller and press the **on** button. The screen should blink and display **donE** when the reprogramming is complete.



7. Press any button to return to normal operation.
8. Verify the software version by holding **U** and **P>** at the same time.
9. Switch off the Electrostatic Controller and remove power from the system.
10. If desired, remove the micro SD card from the slot, or replace the microSD card with another. Having a microSD card in the slot will allow the controller to store log files. See [Setup Screen 7 \(Log Level\)](#), page 48 for information about logging.
11. Replace the controller access cover.
12. Screw down the front access cover.
13. Reapply power and switch on the Electrostatic Controller.



Parts

Electrostatic controller 24Z098 (solventborne system) and 24Z099 (waterborne system)

Part No.	Description
17H039	Discrete I/O Cable (included)
223547	Ground Wire (included)
24Y335	Electrostatic controller Power Cord (included)
— — —	CAN ferrites

Repair Kits

See [Repair, page 67](#), for instructions on removal and installation.

Kit Number	Description
25C425	Main Board, <i>solventborne system only</i>
25C426	Main Board, <i>waterborne system only</i>
17H286	Power Board
17H285	Power Supply Board
17H283	Button Panel
17H282	LCD Panel
25C427	CAN Board
25E312	Power Board Fuse (Qty 5)

Accessories

Power Cables

Part No.	Description
17J586	Power Cable; 36 ft (11 m)
17J588	Power Cable; 66 ft (20.1 m)
17J589	Power Cable; 99 ft (30.2 m)

Mounting Brackets

Part No.	Description
17H288	Bracket, wall mounting, for 24Z098, 24Z099

Software

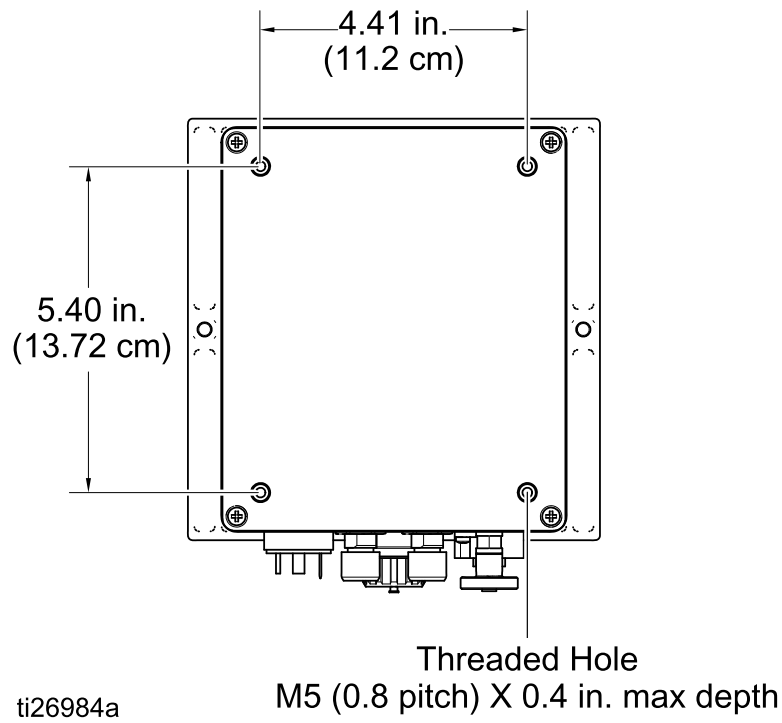
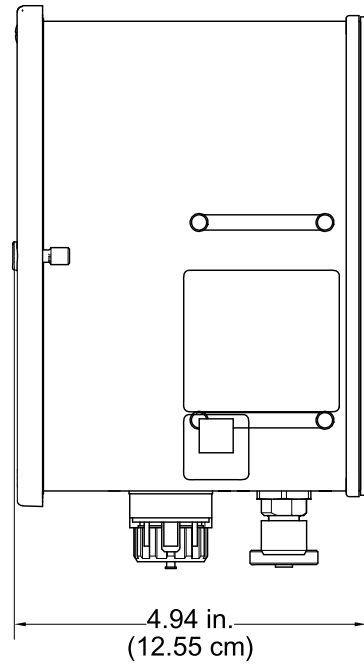
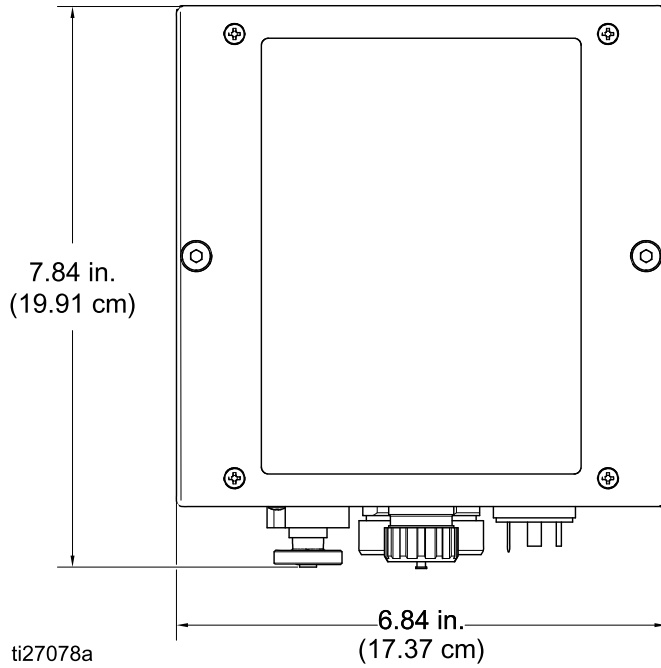
Part No.	Description
17J278	Software, main board
The software does not affect the portion of controller memory that defines the type of system.	

Graco CAN Cables

Part No.	Description
130193	0.5 m (1.6 ft)
121001	1 m (3.3 ft)
121002	1.5 m (4.9 ft)
121003	3 m (9.8 ft)

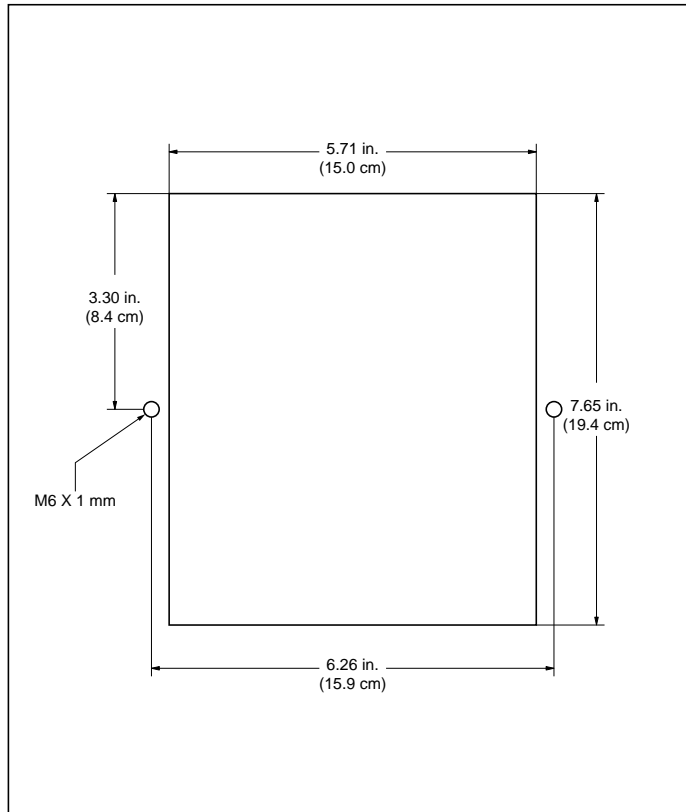
Dimensions

Controller

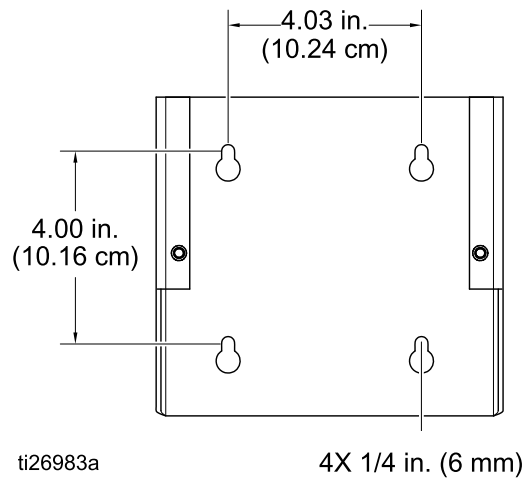


Dimensions

Flush Mount



Wall Mount Bracket 17H288



Technical Specifications

ProBell Electrostatic Controller		
	U.S.	Metric
Nominal Input Voltage	100–240 VAC	
Frequency	50–60 Hz	
Input Power	40 VA	
Nominal Output Voltage (to the applicator)	eff 10V	
Nominal Output Current (to the applicator)	max 1.2 A	
External Power Requirements	100-240 VAC, 50-60 Hz, 1 amp maximum draw, 15 amp maximum circuit breaker recommended	
Protection Type	IP54	
Ambient Temperature Range	41°F - 104°F	5°C - 40°C
Dimensions		
Width	6.8 in.	173 mm
Depth	4.8 in.	122 mm
Height	7.5 in.	191 mm
Weight	approx. 4.5 lbs.	approx. 2.0 kg

Graco Standard Warranty

Graco warrants all equipment referenced in this document which is manufactured by Graco and bearing its name to be free from defects in material and workmanship on the date of sale to the original purchaser for use. With the exception of any special, extended, or limited warranty published by Graco, Graco will, for a period of twelve months from the date of sale, repair or replace any part of the equipment determined by Graco to be defective. This warranty applies only when the equipment is installed, operated and maintained in accordance with Graco's written recommendations.

This warranty does not cover, and Graco shall not be liable for general wear and tear, or any malfunction, damage or wear caused by faulty installation, misapplication, abrasion, corrosion, inadequate or improper maintenance, negligence, accident, tampering, or substitution of non-Graco component parts. Nor shall Graco be liable for malfunction, damage or wear caused by the incompatibility of Graco equipment with structures, accessories, equipment or materials not supplied by Graco, or the improper design, manufacture, installation, operation or maintenance of structures, accessories, equipment or materials not supplied by Graco.

This warranty is conditioned upon the prepaid return of the equipment claimed to be defective to an authorized Graco distributor for verification of the claimed defect. If the claimed defect is verified, Graco will repair or replace free of charge any defective parts. The equipment will be returned to the original purchaser transportation prepaid. If inspection of the equipment does not disclose any defect in material or workmanship, repairs will be made at a reasonable charge, which charges may include the costs of parts, labor, and transportation.

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Original Instructions. This manual contains English, MM 3A3657

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