Integral® Series (Flow Sensor and PLC)

CADARO BASE Software

TECHNICAL OPERATIONS MANUAL

CADARO 600 S Tyler St Suite 2009 Amarillo, TX 79101

Version: 08.22.24v2
Software: 24.05.07

CONTENTS

PRODUCT DESCRIPTION

HOW THE INTEGRAL FLOW SENSOR WORKS

The patented Integral flow sensor from CADARO is designed to measure the real-time flowrate, batch weight, and total accumulated weight of dry flowable materials. Utilizing advanced load cell signal processing technology, the flow sensor is often installed in-line within an existing non-vertical pipe/chute where the material flows. As the product passes through the sensor, it generates an electrical signal that is transmitted to the CADARO PLC control box. The control box employs proprietary software to convert the signal into easily readable data. The Integral brand is synonymous and replaces the previous NV product series.

For seamless integration, the Integral flow sensor can be connected to an existing automation system using the CADARO Modbus TCP communications. This is a CADARO CONNECT Enterprise Plan feature. (Contact CADARO Service for directions).

BEST SUITED APPLICATIONS

The Integral Flow Sensor is particularly well-suited for the following applications:

- Dry flowable materials characterized by low moisture content and relatively clean composition.
- Processes involving the gravity-fed flow of material in a non-vertical direction (45-60 degree angle from horizontal) with a consistent flow rate.
- Facilities equipped to perform material calibration tests during initial setup and as required.

LIMITATIONS

While the Integral Flow Sensor offers exceptional performance in numerous scenarios, it may not be suitable for the following applications:

- Situations involving non-uniform material flow or materials with a long drop, leading to excessive material velocity.
- Environments experiencing abrupt changes in temperature or material moisture, which can affect the accuracy of measurements.
- Installation sites subject to excessive motion, vibration, or exposure to electronic and mechanical shocks.
- Outdoor installations or locations with ambient temperatures below 20°F (-6.7°C) or above 120°F (49°C).
- Applications requiring NTEP certification for legal trade purposes.
- Installation sites located within 5 feet of strong RF waves or electromagnetic interference sources.

To ensure optimal performance and accurate measurements, please note these limitations when selecting the installation location and relying on the Integral Flow Sensor.

ENVIRONMENTAL RATINGS (CONTROL BOX, JUNCTION BOX, AND LOADCELL)

The control box enclosure and the loadcell junction box will be treated separately. Both shall meet Class 2 Div 1 hazardous location ratings. The CADARO equipment is not intended to be used in a Class 1 environment.

The control box contains the PLC, HMI, and other related equipment. (Confirm with CADARO when the ratings below are required for site equipment.)

- Control box NEMA Rating: 6P
- Control box IP Rating: IP67

The junction box contains an electrical union of the loadcell cable to the sensor cable. It is located near or on the sensor box.

- Junction box NEMA Rating: 6P
- Junction box IP Rating: IP67

The loadcell for Integral series are IP Rating: IP67
0°F – 150°F

INTEGRAL SERIES FLOW SENSOR ASSEMBLY AND INSTALLATION

BEFORE INSTALLATION

Verify if the material flow rate falls within the rated capacity of the Integral flow sensor. Calculate the flow rate by measuring the time it takes for a known weight of material (pre- or post-weighed) and convert the measurement to pounds per minute (or as specified for your application). Refer to the chart below to determine the appropriate Integral flow sensor.

Figure 1: Integral Sub-Models Specifications

MODEL	Low Operating Range (lbs/min)*	High Operating Range (lbs/min)*	Inlet/Outlet Pipe Size (diameter round/square)*	Configuration	Flow Sensor Dimensions (L x W x H)	Flow Sensor Weight (lbs)
INTEGRAL NR/2K | INTEGRAL NRL/2K	800	2,000	6" OD	Round	32 ⅛" x 13" x 11 ⅝"	67 | –
INTEGRAL NS/5K | INTEGRAL NSL/5K	1,750	5,000	9 ¾" x 9 ¾" ID	Square	30 ⅜" x 16 ¼" x 15"	135 | 200
INTEGRAL NS/20K | INTEGRAL NSL/20K	5,000	20,000	17 ¾" x 17 ¾" ID	Square	36 ½" x 23 ⅝" x 24 ¾"	210 | 275
INTEGRAL NS/50K | INTEGRAL NSL/50K	17,500	50,000	29 ¾" x 29 ¾" ID	Square	36 ½" x 37" x 35 ⅝"	375 | 425

**Operating range can be calibrated to measure lower flow rates but overall range and accuracy requirements need to be considered.*

Before installation, ensure that the system is in working condition. This check ensures that the sensor has not been damaged during shipment. To perform this check, follow these steps:

ASSEMBLY OF FLOW SENSOR

Note: Your system will include a shipping bolt and a safety bolt. Remove the shipping bolt. For the Integral flow sensor, you may be able to access these bolts from the outlet without removing the side piece. If the side panel is removed, the shipping bolt spacer can be seen above the internal sensing box.

Steps to Remove Shipping Spacer

1. Remove the shipping spacer by loosening the shipping bolt running from the external top of the sensor through the sensing box.
2. Note: If the shipping bolt is tightly secured, apply pressure to the bottom of the inner square sensing box to remove it.
3. Take a smaller length bolt with nut [1/4" x 3/4" standard bolt and 1/4" nut not provided – purchase separately] and insert it into the sensor housing in place of the shipping bolt, making sure it does not extend into the inside of the sensing box, but instead remains flush with the interior surface of the sensing box/housing. Tighten the nut to secure both the bolt and the nut in place.

Steps to Lower the Bottom Shipping Bolts

1. Loosen the nuts on the shipping bolts located on the bottom side of the sensor housing.
2. Loosen the bolts until they are flush with the inside bottom surface of the sensor. There are two bolts, one under each load cell, for the inclined sensor.
3. Leave the bolts flush with the inside bottom surface of the sensor and tighten the nuts.

Once the shipping spacer is removed and the shipping bolts are lowered, place the system on a level/horizontal surface and connect the PLC control box to the sensor using the provided cable.

1. Connect the male end of the load cell cable to the Integral flow sensor junction box and the female end to the to the PLC control box.
2. If the loadcell is reading correctly, there will not be an alarm described as 'Signal Fault' or 'Signal Max'. Apply slight pressure to the interior sensor box and watch for weight to begin accumulating, indicating successful communication with the load cells.
3. If the weight factor is zero or if the load cell weight is signal fault or signal max then refer to the Alarm section below.

System Confirmation with Weight

1. Place a small weight, such as a standard 500 or 1,000 gram weight, onto the sensing plate. If a standard weight is not available, an unopened bottle of water can be used as a substitute.
2. Once placed inside the sensing box, the gross weight should increase steadily, and the net weight should be greater than zero. If this does not occur, please contact CADARO as it is possible that your sensor has been damaged during shipment.
3. **Note:** Resecure the sensing box using the shipping bolts and shipping spacers to protect your system during installation. Ideally, the removal of the shipping spacer and lowering of the shipping bolts within the sensor should be done after installation. However, if it is difficult to access all areas post-installation, these steps can be performed before installation; however, the unsecured unit must be handled with care.

SENSOR INSTALLATION

Best Practices/Guidelines

1. A manual gate or choke immediately upstream or downstream of automatic gate will ensure consistent and repeatable flow.
2. Certain system configurations may require the inclusion of gate/choke immediately upstream of the flow sensor.
3. The direction of gate travel should be oriented to direct the incoming material pathway along the bottom portion of the flow sensor. Avoid orientations that direct material towards the top side of the flow sensor.
4. For installations without a gate or choke, avoid placement of the sensor near inflection points that change either the direction or speed of material flow.

Angle of Installation

The Integral Flow Sensor should be installed at an angle where the dry flowable material being measured flows through a chute and contacts the internal sensing plate. The material should not be free-falling, but instead material should flow in a uniform, consistent manner making even contact with the internal bottom and side surfaces of the sensor. Install the sensor at an angle which ensures proper flow, generally between 45 and 60 degrees from horizontal.

Installation Considerations

The sensor will come with an inlet and outlet pipe or bolt holes on the inlet/outlet flange for installation. Do not use the main body between the inlet/housing or outlet/housing to secure the sensor. Ensure that the sensor is leveled perpendicular to the direction of flow. Material should flow over the internal sensing plate in an even and consistent (imagine water or thick oil/cheese-like) manner. Use a level to verify that the sensor is level in the plane perpendicular to the direction of product flow. An angled installation can negatively affect accuracy.

Important: Avoid operating welding equipment in the vicinity of the Integral flow sensor when it is installed. Prior to any welding activities near or on the equipment where the Integral flow sensor is installed, remove the Integral flow sensor. Any damage caused to the Integral flow sensor by welding equipment will not be covered under the warranty. Refer to Section 10 for further details.

POST-INSTALLATION

After a 30-minute waiting period, enter your customer specific license provided by CADARO.

PLC CONTROL BOX INSTALLATION

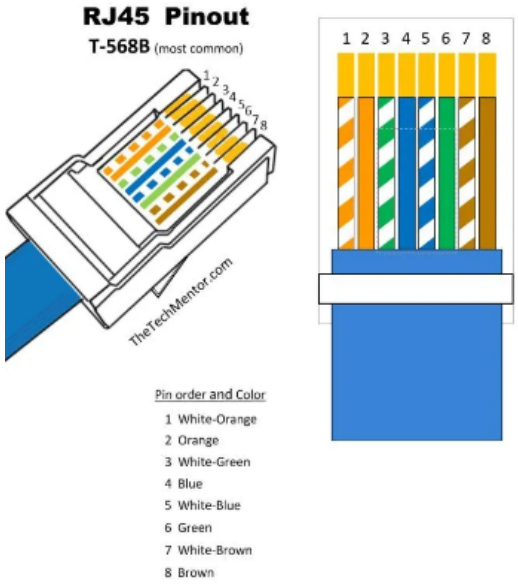
BOX LOCATION

Choose a safe, dry, and convenient location to mount the PLC control box.

We recommend the total cable length between the control box and sensor box be no more than 300 feet. Connect the RJ45 end at the Veracity flow sensor box to the RJ45 end at the PLC control box.

Depending on the customer, a prefabricated signal cable or a bulk cable without ends may be included. In either case, this cable may be altered to the customer's liking. Qualified personnel should follow the pinout diagram below to ensure the wiring is done correctly. Necessary tools are required.

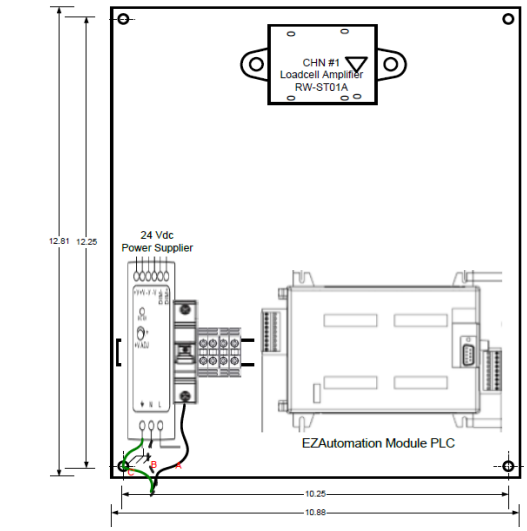
Figure 2: RJ45 Pinout Diagram



Important: Avoid placing the PLC control box in direct sunlight. Treat the PLC control box with the same care as a computer and avoid placing it where it will be exposed to less-than-ideal conditions. CADARO recommends placing the control box inside a building or, if that is not possible, in its own enclosure to provide shelter and protection from external conditions.

PLC CONTROL BOX POWER REQUIREMENTS

Figure 3: PLC Power Wiring Diagram



The PLC control box is designed to be plugged into a standard 120V AC outlet. (Reference the chapter and section titled Specifications, Required Power and Suggested UPS.)

PLC MODBUS TCP DESCRIPTION

For installations with an existing automation system, the Integral flow sensor signal can be managed and delivered via Modbus TCP to an existing automation platform. Our PLC acts as the slave device storing data inputs and outputs to registers accordingly.

More about the Modbus is found in the Initialization section below. This is a CADARO CONNECT Enterprise Plan feature. See "CADARO ENTERPRISE Software Technical Operations Manual" for further instruction.

PLC MODBUS TCP PIN ASSIGNMENT

The connector used is a standard RJ45 Ethernet connector. The connector pinout is the same as described above in Figure 2.

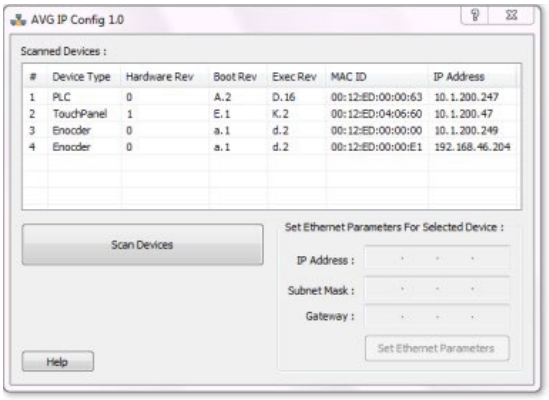
PLC IP ADDRESS

1. Record the settings you currently have on the Main Menu > Calibration > Load Cal Factors.
2. Download the IP configuration program (AVG IPConfig 1.0.2 for Windows) onto your PC.
3. Connect one ethernet cable from your PLC control box RJ45 Port to your PC.
4. Open the PLC control box and confirm that there is an ethernet cable connection between the PLC component, and the RJ45 plug on the bottom side of the PLC control box.
5. If there is no ethernet cable between the RJ45 and the PLC component, plug directly into the ethernet jack on the PLC component.
6. Make sure all devices are powered on.
7. Install and open the 'AVG IPCofig' program on your PC and click on "Scan Devices."

SIGNAL AMPLIFIER

The amplifier communicates with the PLC via Modbus. It is required that there be an additional Modbus network IP address assigned to the amplifier. The configuration for this amplifier is done during manufacturing.

Figure 4: AVG IP Config Dialog Box



- If you only have a connection between the PLC control box and PC, it should detect only one device.
- If you have multiple networks, choose the device you want to edit from the list.
- If necessary, change the IP address, Subnet mask, and gateway to your choice. Press "Set Ethernet Parameters" and wait for the system to update.

1. Power cycle (restart) the control system and "Scan Devices" to ensure the IP settings are as desired. It is necessary to restart the PLC control box to engage the new IP Address. Restart PLC by turning off the power breaker for 30 seconds and turning it back on.

Figure 5: AVG IP Config IP Parameters

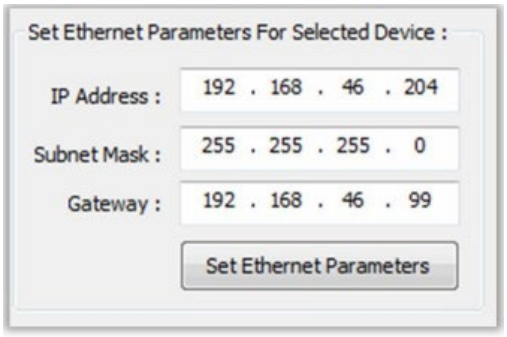


Table 1: Typical IP Parameters

IP Address	192	168	1	X
Subnet Mask	255	255	255	0
Gateway	Empty			

- Typical private network ethernet parameters example. Consult IT or CADARO for further support if needed.

It is recommended to store the IP address within the PLC control box for future reference either on a flash drive that is kept INSIDE the PLC control box (but not plugged into anything) or written down on a piece of paper or notepad and stored INSIDE the PLC control box for easy reference.

START-UP INSTRUCTIONS

STARTUP

Pre-Licensed Screen

Figure 6: Unlicensed Loadout/Startup Screen

Licensed Screen

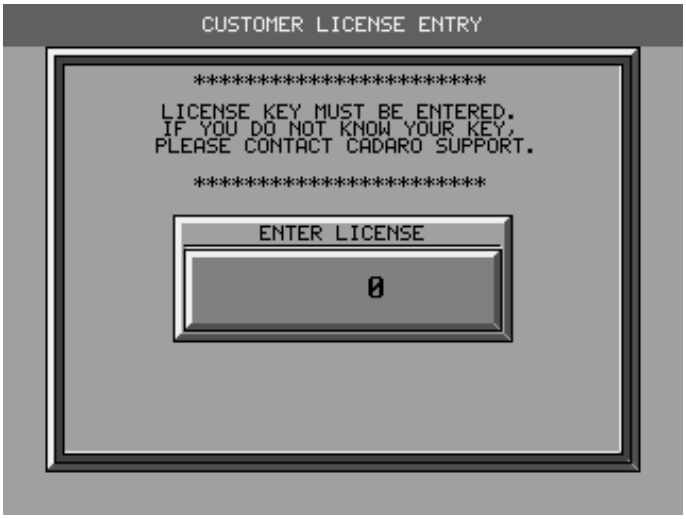
Figure 7: Licensed Loadout/Startup Screen

'Loadout Summary' screen can be treated as a lock screen. To leave the 'Loadout Summary' screen requires a password that can be held confidential, from Truckers for example.
This screen can be later accessed from the 'Flow Sensor Menu' screen.

LICENSING

Pre-Licensed Screen

Figure 8: Unlicensed Screen



From bootup, if license has not been configured, the above screen will appear.

Figure 9: License Accepted Screen.

Enter the prescribed license, if correct, the software will allow for advancement to the below screen.

Post-Licensed Startup Screen

Figure 10: Licensed Bootup or Post-License Entry Screen

From bootup, if license has been previously accepted, the above screen will appear. This screen will also appear after the correct license has been entered.

INITIALIZATION

Pre-Initialized

Figure 11: Before Any Initialization

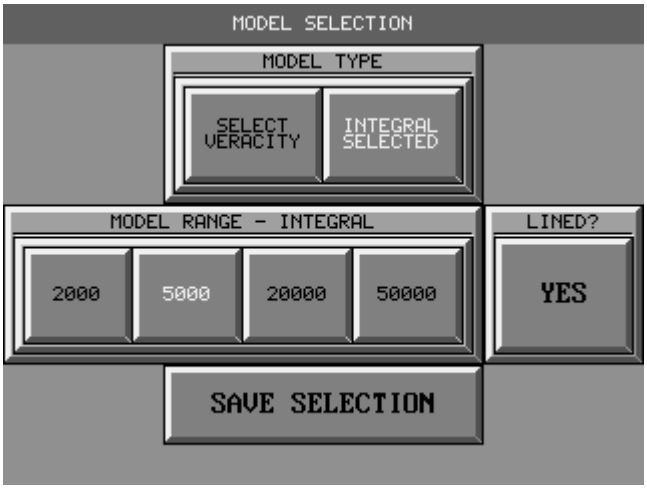
As seen before anything has been initialized to a specific customer or flow sensor box. Please verify the 'Software Version' matches what CADARO has prescribed. If not, contact CADARO.

If operator prefers metric units, now is the time to toggle the 'Select Units' button to 'Metric Selected'.

'Setup Comms/IO' is only accessible by having a CADARO CONNECT Pro or Enterprise Plan. The functionalities within this option are described in further detail below.

Model Selection

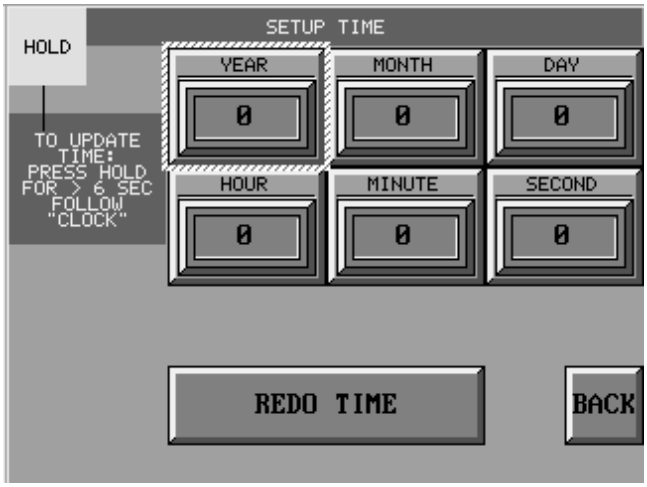
Figure 12: Model Selection Screen



Take care when selecting the model type and range. The model selection step can only be performed once, thereafter, the license will need to be reinitialized.

Time

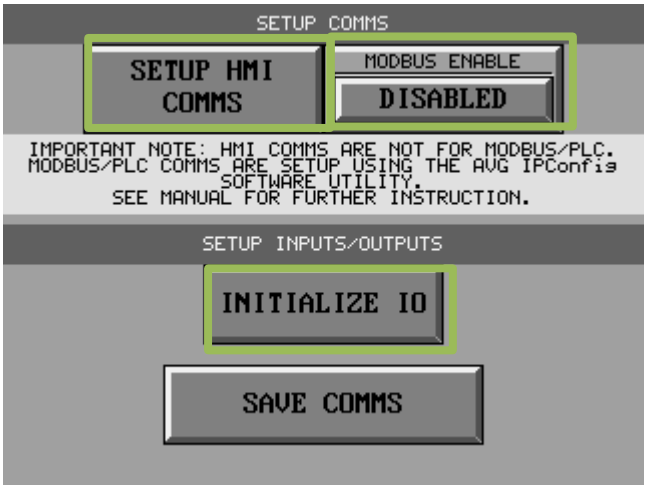
Figure 13: System Time Setup Screen



The system time is important for datalogging time stamps.
To manually update time, gently press and hold the top left 'HOLD' button for over 6 seconds.

Setup Communications and IO

Figure 14: Comms, Modbus, and IO Setup Screen



'Setup HMI Comms' and 'Modbus Enable' require a CADARO CONNECT Enterprise Plan. HMI Comms will allow for remote access to the HMI screen and/or the stored data from a desktop.

Modbus turns on the data within the software to allow for remote monitoring and/or control.

If Enterprise Plan subscriber: See "CADARO ENTERPRISE Software Technical Operations Manual" for further instruction.

- "HMI Comms Technical Data Sheet"
- "Modbus Technical Data Sheet"

'Initialize IO' is only accessible for CADARO Pro Plan subscribers. See "PRO Software Technical Operations Manual".

Figure 15: Analog IO Setup Screen

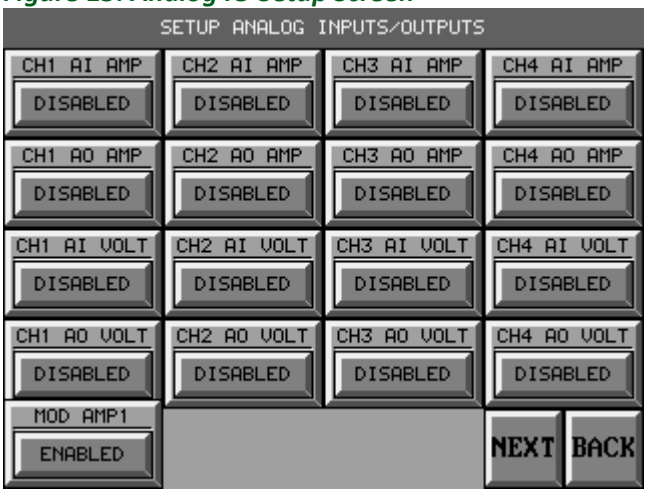
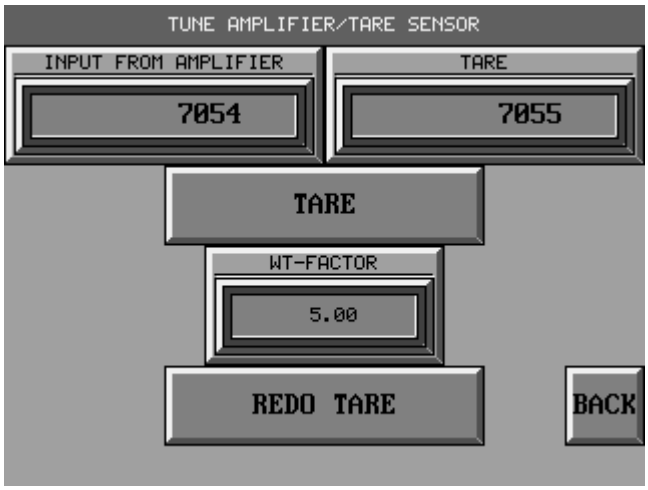


Figure 16: Discrete IO Setup Screen

Tune Amplifier/Tare Sensor

Figure 17: Amplifier, Tare, and Wt-Factor Screen



The 'tune amplifier/tare sensor' screen is used to visualize the reading from the amplifier for tuning purposes and tare the net reading if needed. Tuning is typically only needed once by CADARO. If CADARO Support prescribes tuning, the instructions will be delivered at that time.

Taring is meant to be an automatic functionality. If you find the tare does not match the raw (amplifier reading), a manual tare shall be done.

The 'WT-Factor' value should be reflected in this table.

Table 2: WT Factor Table

Model	Weight Factor
NR 2K	7
NRL 2K	10
NS 5K	8
NSL 5K	11

NS 20K	15
NSL 20K	18
NS 50K	20
NSL 50K	23

If the Weight Factor does not match this table, as per the selected model, contact CADARO.

Post-Initialization

Figure 18: After All Initialization Is Complete

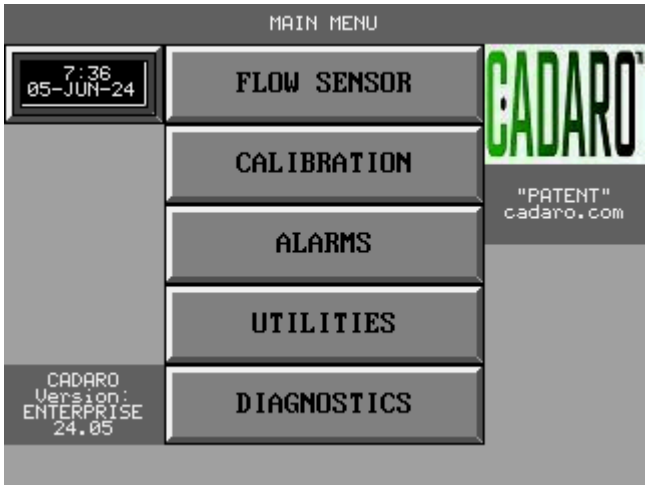
If for any reason the 'Model Selection' needs to be redone, the confirmation screen below will appear.

Figure 19: Void License Confirmation

If 'Continue' is clicked, the license will void and a new license will be required to proceed.

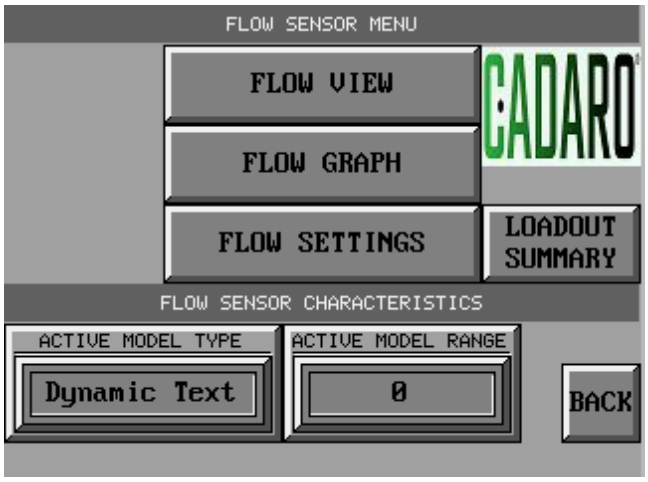
MAIN MENU

Figure 20: Main Menu Screen. For Post-Initialization Tasks



FLOW SENSOR

Figure 21: Flow Sensor Menu Screen



Double-Check the 'Active Model Type' and 'Active Model Range' match the installed sensor box characteristics.

'Loadout Summary' screen can be treated as a lock screen. To leave the 'Loadout Summary' screen requires a password that can be held confidential, from Truckers for example.

Flow View

Figure 22: Flow View Screen. No Controls Enabled

Figure 23: Flow View Screen. All Controls Enabled

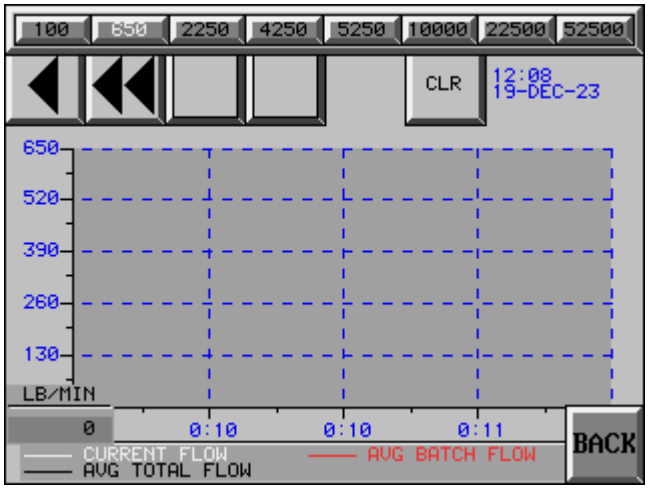
Flow Sensor View screen is intended to be the default screen for operator use once device has been fully initialized and calibrated. Feel free to reach out to CADARO if there are any requests for alterations to this screen.

The target weight capability requires CADARO CONNECT Pro Plan. See "CADARO PRO Software Technical Operations Manual". More information on 'Target Presets' is below.

The air blower capability requires CADARO CONNECT Pro Plan. More information on 'Air Control' is below.

Flow Graph

Figure 24: Flow Graph Screen

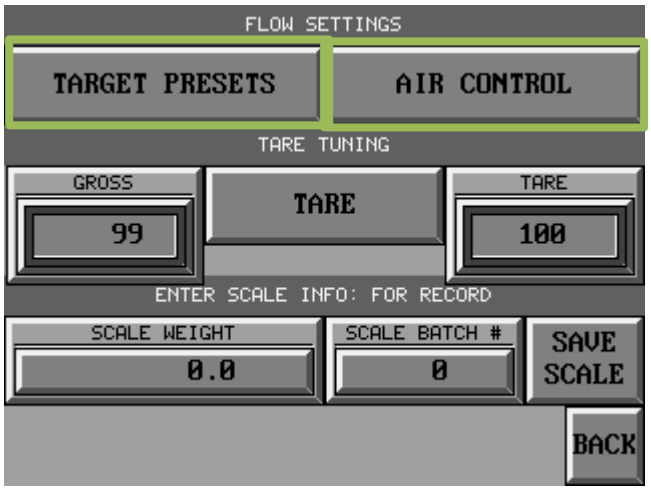


The Flow Graph screen allows for a trendline and historical visual representation of the 'Current Flow', 'Average Batch Flow', and 'Average Total Flow'. If you request a different value to be trended, contact CADARO.

The y-axis (lbs.) is preset adjustable on the top option bar.

Flow Settings

Figure 25: Flow Settings Screen



'Target Presets' and 'Air Control' are covered in further detail below.

The 'Tare Tuning' section of this screen allows for gross to tare check and manual tare if needed. This performs the same function as the 'Initialization' screen 'Tune Amplifier/Tare Sensor'.

The 'Enter Scale Info: For Record' section allows for manual entry of the scale weight and respective batch for the scale weight. This data saves to the microSD card upon clicking 'Save Scale'. This data can later be used as reference.

Flow Settings: Target Presets

Figure 26: Target Presets (Percent Setpoint) Screen

Figure 27: Target Presets (Weight Setpoint) Screen

The target preset functionality is intended to be used as a controllable output of the PLC when the target is met.

Example: If the target is 80,000 lbs., PLC will shut slide gate at 79,000 lbs. to meet the target. This is tunable.

The target weight capability requires CADARO CONNECT Pro Plan. If Pro Plan subscriber: See "CADARO PRO Software Technical Operations Manual", "Target Preset Technical Data Sheet" for further instruction.

Flow Settings: Air Control

Figure 28: Air Control Screen

The auto/manual air blower control is intended to clean the flow sensor after each batch or other criteria.

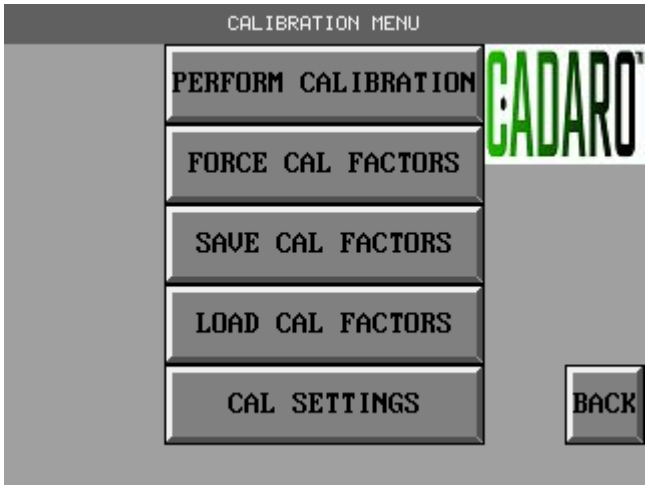
Example: Heavy buildup of dust or residue from material may cause inaccurate readings.

The air blower capability requires CADARO CONNECT Pro Plan. If Pro Plan subscriber: See "CADARO PRO Software Technical Operations Manual", "Air Control Technical Data Sheet" for further instruction.

CALIBRATION

Calibration Menu

Figure 29: Calibration Menu Screen



All calibration functions derive from this 'Calibration Menu'

Perform Calibration Menu

Figure 30: Perform Calibration Menu Screen

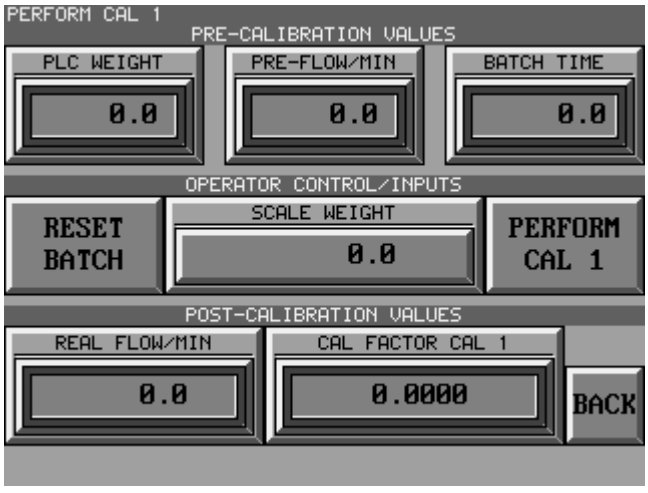
Note: 'Perform Cal 2' option only appears after Cal 1 has been performed.

'Stop Batch' is used only for calibration scenarios when the process of material is not capable of smooth/quick starts and stops. It can also be used for scenarios when the flow rate of a process takes time to build up to or slowdown from. Pressing 'Stop Batch' will force the software to stop calculating flow, even if material is still flowing.

The physical batch of material used to calibrate a run will need to closely match the calculated batch. Meaning, a manual bypass gate or needs to be swung at the same time 'Stop Batch' is pressed.

Perform Cal 1

Figure 31: Perform Calibration 1 Screen



Calibration screen for Cal 1 depicts three rows of information.

- Row 1 at the top are all pre-calibration values. These values are used as a baseline to calculate 'real' values in row 3.
- Row 2 is for operator control/input.
  1. Ensure the batch has been reset before running a calibration batch.
  2. Input scale weight after material has stopped flowing. This scale weight shall be for the

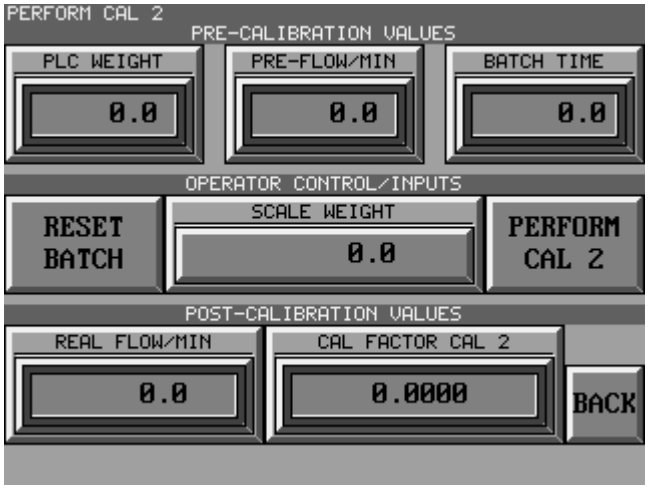
respective calibration batch run.

3. Press 'Perform Cal 1' after scale weight has been submitted.

- **Row 3** is real values calculated from pre-calibration and scale weight values.

Perform Cal 2

Figure 32: Perform Calibration 2 Screen



When a second calibration point is performed and calculated by the software, it is called 'Two-Point Cal'.

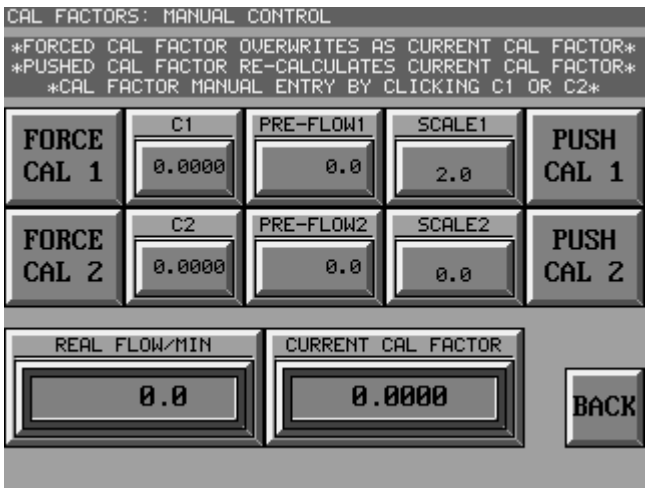
Calibration 2 screen is similar to Calibration 1 screen.

- 'Two-Point Cal' uses Cal 1 factors and Cal 2 factors to create a linear slope of calibration information.
- This calibration information is used to apply the appropriate Cal factor to the respective real flowrate along the slope of calibration.

Note: The difference in flowrate between Cal 1 and Cal 2 shall be greater than the 'Cal % Difference' setting. This setting is addressed below in the 'Cal Settings' section.

Manual Cal Factors

Figure 33: Manual Cal Factor Control Screen



From this screen, calibration values can either be forced or pushed. This screen also acts as a helpful calibration summary screen.

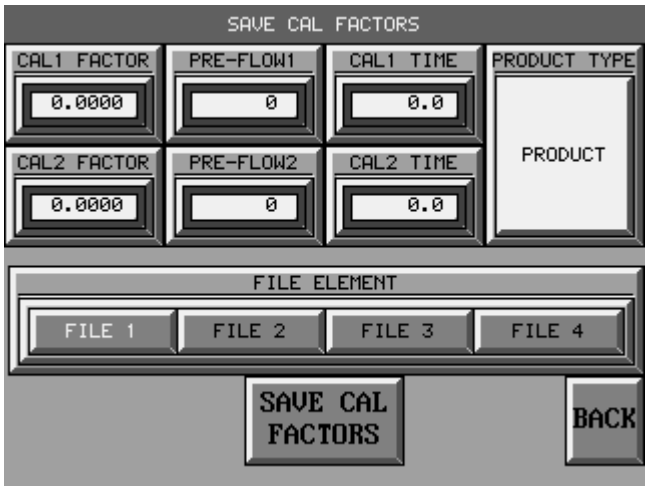
- Forcing will overwrite all predetermined Cal values. This applies to two-point Cal as well.

- Forcing Cal values for C1 or C2 is done by pressing 'Force Cal 1' or 'Force Cal 2'.
- Only a single force can be active at any given time.
- The C values can be manually changed by clicking C1 or C2 and editing the value.
- Pushing Cal reverse calculates the calibration information from the real value state to the pre-calibration state.
- Pushing Cal values for C1 or C2 is done by pressing 'Push Cal 1' or 'Push Cal 2'.
- 'Push Cal 2' will appear after Cal 1 has either been completed normally or pushed.

Note: This should only be used if the values entered are accurate to a previous "normal" calibration run.

Save Cal Factors

Figure 34: Save Cal Factors Screen



After a calibration has been performed, the active calibration values will be auto populated onto the 'Save Cal Factors' screen.

- This is where a product or flowrate profile can be saved to the software. Select a 'File Element' to save to before clicking 'Save Cal Factors'. If saving to a previously occupied 'File Element' all previously saved information in that particular 'File Element' will be overwritten.
- The 'Product Type' section allows for shorthand notes about the profile. Limited to 10 characters. Examples may include 'Soybean', 'CornFlow2k', 'Milo2Point', '9Aug2023', etc.
- The software will store up to four profiles for future loading to the active calibration when needed. The active profile is always the one loaded into the values on this screen.

For manual saving of calibration information, refer to the below table for guidance.

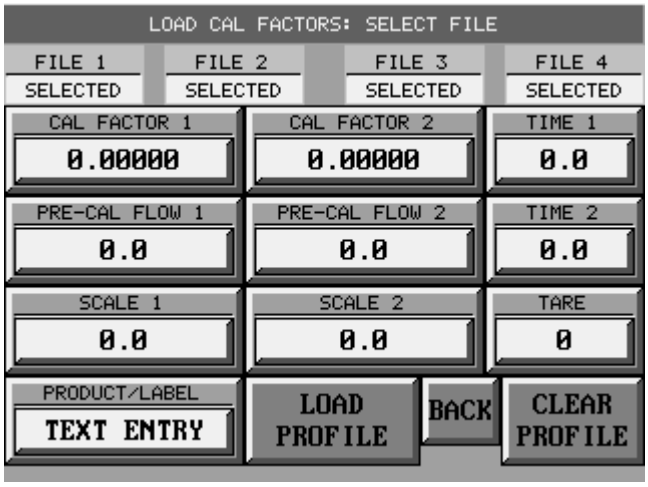
Table 3: Calibration Profile Saving Example

	File 1	File 2	File 3	File 4
CAL1				
CAL2				
Pre-Cal Flow1				
Pre-Cal Flow2				
Time1				
Time2				
Scale1				
Scale2				
Tare				
Product				

You may also email the calibration information to CADARO directly at info@cadaro.com

Load Cal Factors

Figure 35: Load Cal Factors Screen



This is the repository of the saved calibration profiles. Four files are depicted with 'File 1' being selected in this picture.

- Select any of the four files by clicking anywhere on the respective column. If selected, the white color will appear behind the data.
- Select 'Load Profile' when ready. On the 'Save Cal Factors' screen, the loaded profile is now the active profile.
- 'Clear Profile' will delete the selected profile.

Cal Settings: Password Protected for Supervisor Level Access

Figure 36: Calibration Settings Screen

The 'Cal % Difference' is an allowable range between Flowrates for Cal 1 and Cal 2.

- For instance, Cal 1 Flowrate of 100 and Cal 2 Flowrate of 79 is acceptable. The % difference is 21%.
- This setting is meant to inform the user of calibration flowrate values being too close, which can cause two-point calibration calculation problems.
- If this condition is violated, it will produce an alarm and nothing more. Specifically, it will continue the calibration calculations as normal, even if they are malfunctioning.

ALARMS

There are seven alarms pre-programmed into the software:

Table 4: Alarm List

Alarm Name	Severity	Solution – Contact CADARO If Needed
Panel/HMI Battery Low	Low	Follow procedure to replace battery with exact match battery
PLC Battery Low	Low	Follow procedure to replace battery with exact match battery
Signal Fault	High	Signal reading 0. Bad loadcell or faulty wiring.
Signal Max Reading	Medium	Signal reading max. Bad loadcell or too much flow.
Auto-Tare Fault	Medium	Tare value not updating. Signal issue or not in auto.
Cal Flowrates Too Close	Low	Cal settings need adjustment. Cal 2 flowrate needs to change.
Uncomputable Cal Factor	High	Cal settings and/or results are not satisfactory for computation.

Alarm List

Figure 37: Alarm Summary Screen

All active alarms will be shown here. Refer to the alarm list above for more information.

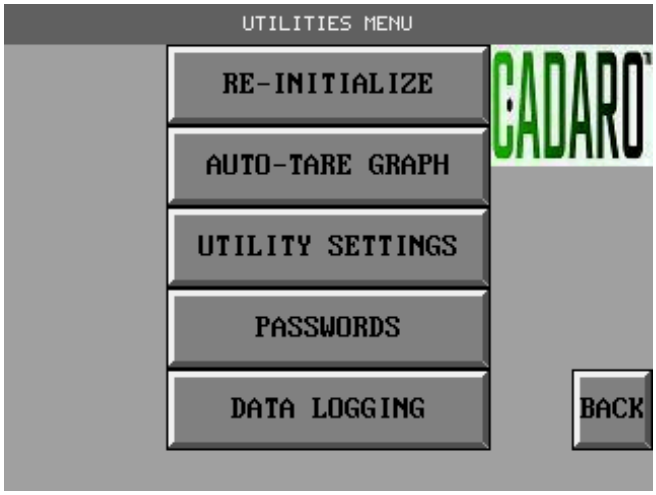
Alarm History

Figure 38: Alarm History Screen

All alarms whether active or not will show here. The alarms can be cleared if necessary by clicking 'Clear All'.

UTILITIES: PASSWORD PROTECTED FOR SUPERVISOR LEVEL ACCESS

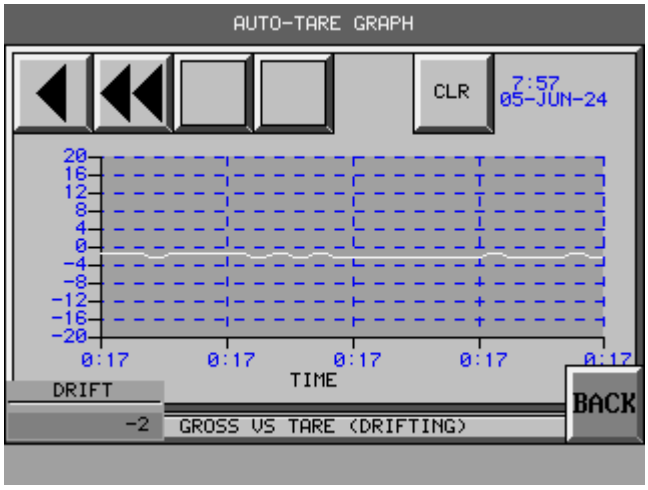
Figure 39: Utilities Menu Screen



- *Re-Initialize* will navigate the user to the 'Initialization' screen.

Auto-Tare Graph

Figure 40: Auto-Tare Graph Screen

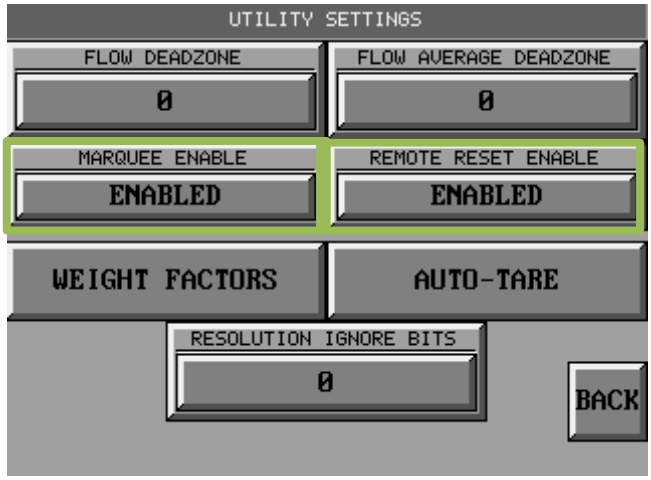


The 'Auto-Tare Graph' screen is used to visualize the 'noise' of the signal.

- This is a direct comparison of the gross (raw) value from the sensor to the tare (zero) value of the software.
- The 'noise' could be from a handful of interactions to the PLC or Loadcell. For example: radio interference, vibration, temperature, etc.
- If auto-tare is enabled, the drift will re-tare when the drift is beyond the tare dead zone for more than one second.

Utility Settings

Figure 41: Utilities Setting Screen



Flow Deadzone and *Flow Average Deadzone:* The values used to determine active flow. For example: If the tare is 100 and flow dead zone is 20, then gross will need to be greater than 120 for flow to be considered active.

Possible reasons to change *Flow Deadzone*:

- Considerable noise causing the signal to bounce above the dead zone without actual flow of material. This problem should be fixed in a different way for a long-term solution.
- Material is light weight or slow flow where the signal is not moving enough to be considered active.

Marquee Enable: An optional installation of a remote LED data display device, or Marquee, can be activated. The *Marquee* capability requires a CADARO CONNECT Enterprise Plan.

- If Enterprise Plan subscriber: See document named "CADARO Marquee Tech Sheet".

Remote Reset Enable: A hardwired push button can be installed to allow for remote resetting of the batch. If other criteria are requested for use by a hardwired push button, please reach out to CADARO Support. The *Remote Reset Enable* capability requires CADARO CONNECT Pro Plan.

- If Pro Plan subscriber: See document named "CADARO Remote Reset (Hardwired) Tech Sheet".

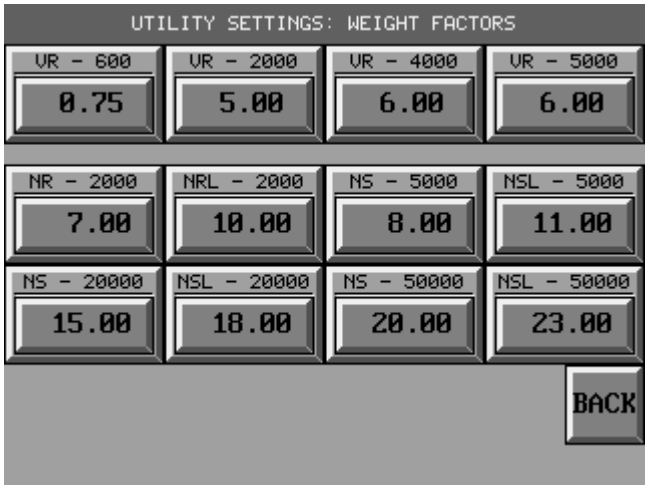
Weight Factors: Separate screen with multiple options described below.

Auto Tare: Separate screen with multiple options described below.

Resolution Ignore Bits: A setting determined during calibration. After calibration, it should be left as is.

Utility Settings: Weight Factors

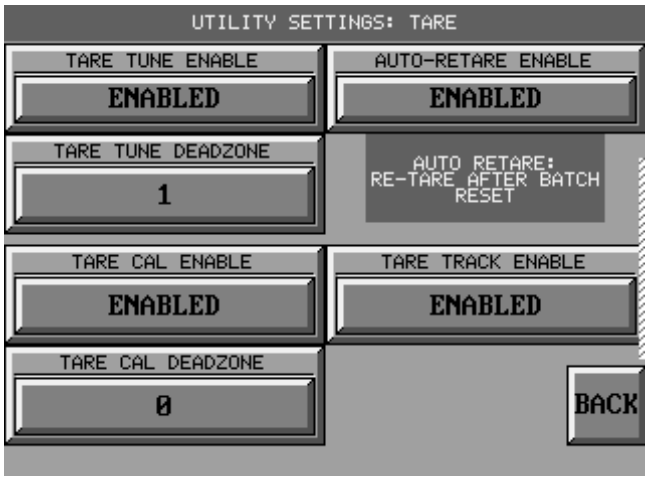
Figure 42: Weight Factors Screen



Each sensor box has an assigned flow rate capacity as well as a weight factor. This weight factor is what the software uses to calculate the pre-calibration values. These factors should only be adjusted after discussion with CADARO Support.

Utility Settings: Tare

Figure 43: Tare Screen



This is 'Auto-Tare' functionality, and it is default enabled. When enabled, the tare will adjust itself to follow any deviations in gross (raw) over time.

The *Tare Deadzone* is the value used to determine if gross has drifted too far from tare, i.e. if gross-minus-tare is greater than 'Tare Deadzone' for greater than five seconds, the tare will 'Auto-Tare'.

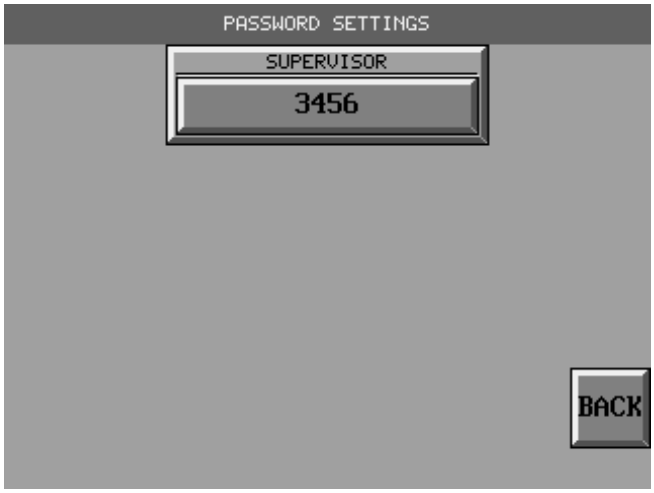
The 'Auto-Retare' functionality is default enabled. When enabled, the software will perform a tare each time the batch is reset. This is regardless of drift status.

Tare Cal Enable: May or may not be used during initial setup. It should be left as is. Same with Tare Cal Deadzone.

Tare Track Enable: May or may not be used during initial setup. It should be left as is.

Passwords

Figure 44: Passwords Screen



The 'Supervisor' password is adjustable by the supervisor only. The default is password '3456'. If changed, do not forget it. This is the only password customers can use to access certain areas of the product functionality.

Data Logging

Figure 45: Data Logging Screen

There are a handful of pre-programmed scenarios in which data is logged to the on-board microSD card. The PLC manufacturer suggests a 4 GB microSD card, but it has been successful with up to a 32 GB. The card shall be formatted to 'FAT32' with default allocation size.

This functionality is enabled and running by default.

- If ever there is a blinking notification on the top-left of any screen saying, 'Data Not Logging', please contact CADARO.
- To remove the microSD card or start/stop data logging, follow the on-screen instructions.

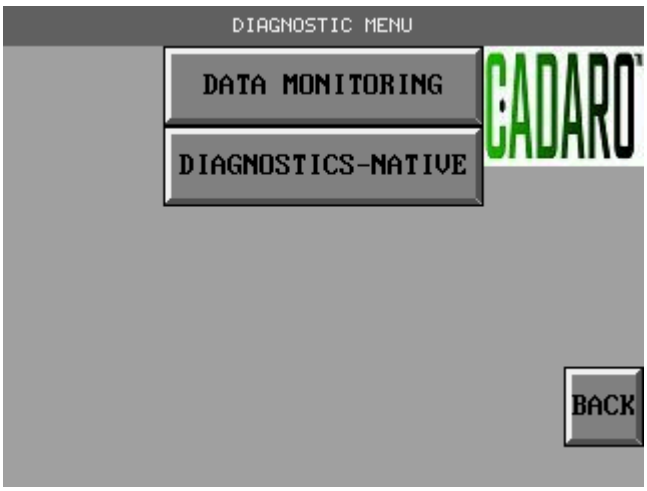
The data logging scenarios and data logged is as follows:

Table 5: Data Logging Criteria

Log Trigger	Data Logged
Batch Reset	Batch Total Batch Number Batch Time Batch Average Flowrate/Min Tare Cal 1 Batch Time Cal 1 Batch Weight Cal 1 Factor Cal 1 Scale Weight Cal 1 Flowrate/Min Cal 1 Pre-Calibration Flowrate/min Cal 2 Batch Time Cal 2 Batch Weight Cal 2 Factor Cal 2 Scale Weight Cal 2 Flowrate/Min Cal 2 Pre-Calibration Flowrate/min
Active Batch	Batch Number Gross Tare Batch Mini-Number Tare Calibration Status Tare Calibration
Scale Save	Scale Weight Scale Batch

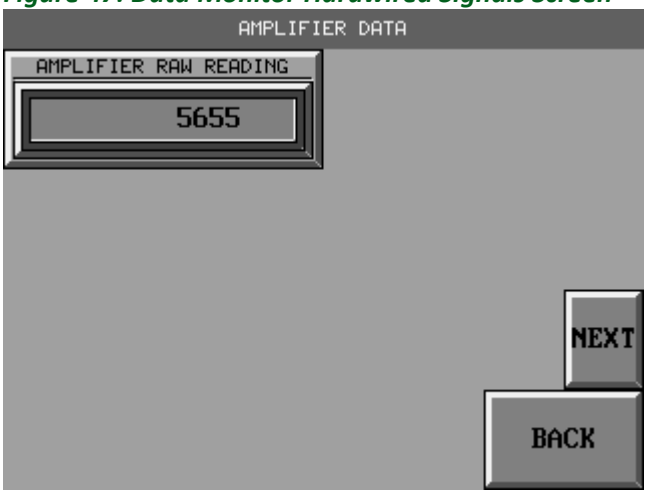
DIAGNOSTICS: PASSWORD PROTECTED FOR SUPERVISOR LEVEL ACCESS

Figure 46: Diagnostics Menu Screen



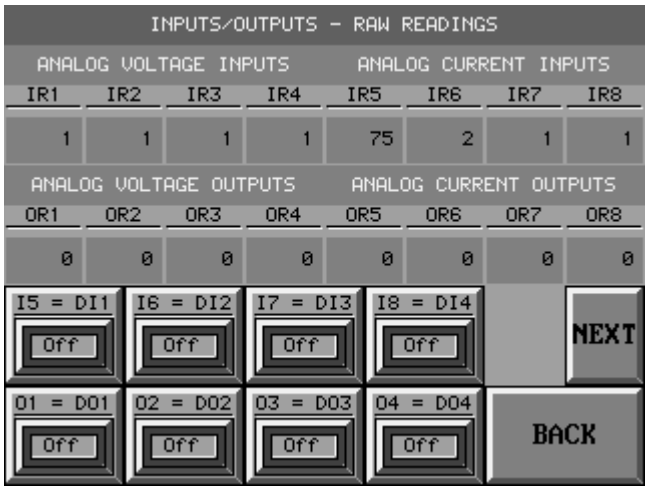
Data Monitoring

Figure 47: Data Monitor Hardwired Signals Screen



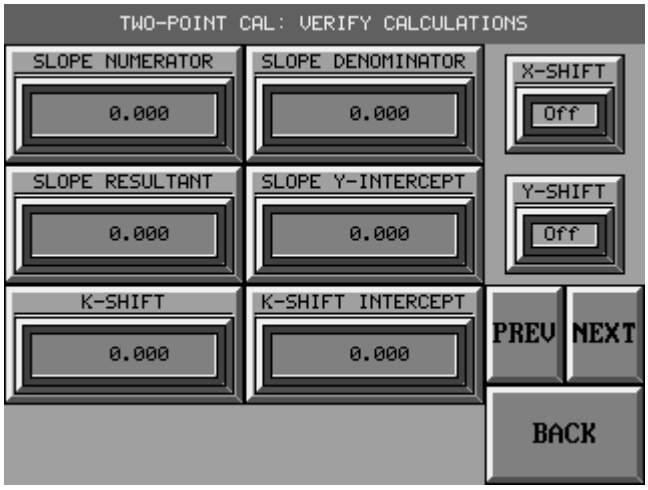
Amplifier Raw Reading is the value from the amplifier.

Figure 48: Data Monitor Hardwired Signals Screen



'Raw Readings' is the active status of all analog inputs and outputs and all digital inputs and outputs.

Figure 49: Data Monitor Two-Point Cal Screen



'Two-Point Cal' is used by CADARO to help troubleshoot any issues with 2-point Cal calculations.

Figure 50: Data Monitor Modbus Reads 1 Screen

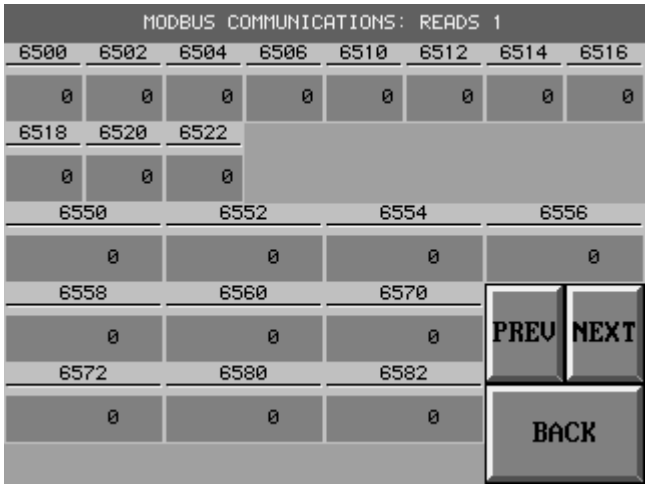


Figure 51: Data Monitor Modbus Reads 2 Screen

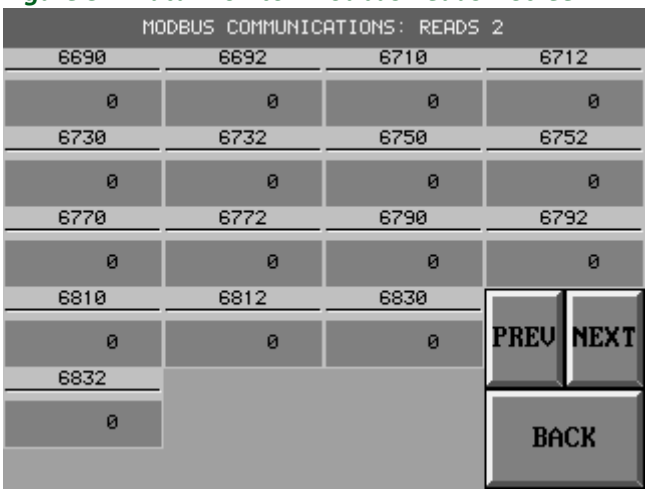


Figure 52: Data Monitor Modbus Reads 3 Screen

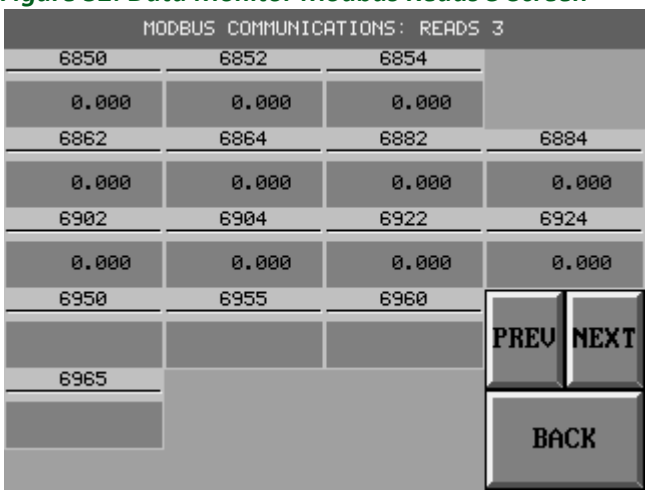


Figure 53: Data Monitor Modbus Writes 1 Screen

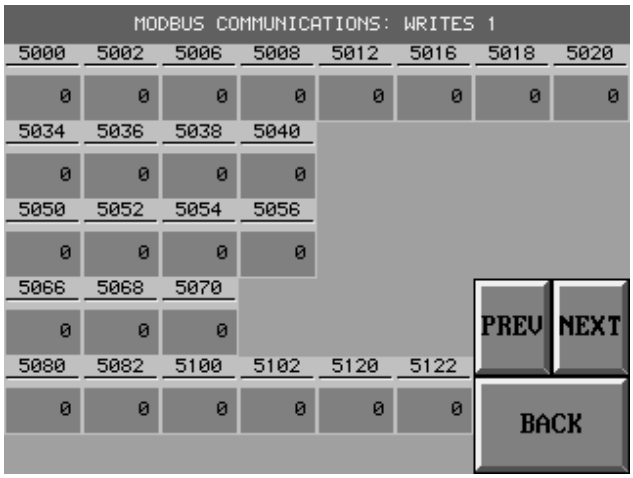
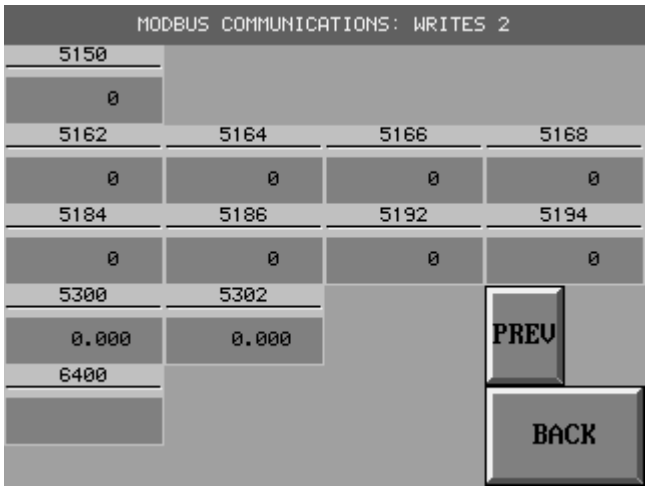


Figure 54: Data Monitor Modbus Writes 2 Screen



Diagnostics-Native: Password protected for Master level Access

LOADING SOFTWARE FROM USB FILE

In special circumstances, CADARO may provide the customer with a USB drive. This drive will be preloaded with a file ready for download to the HMI.

Place the USB file into the 'Host' port on the HMI.

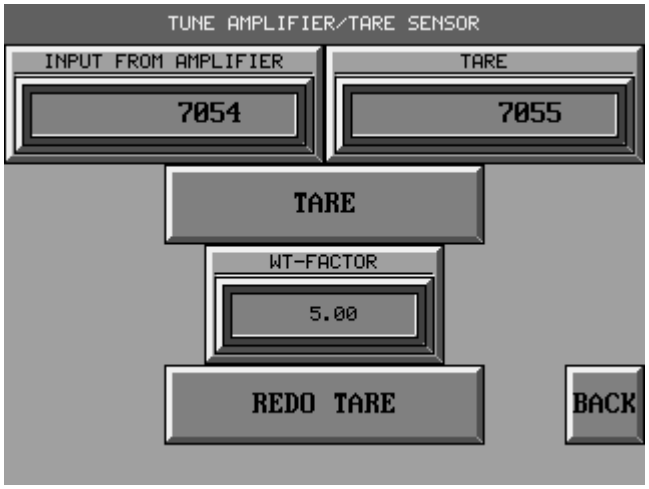
Figure 55: USB Port on HMI

- The HMI screen will automatically load a screen displaying all recognizable files.
- Ideally there will only be one file, select 'Accept' for it to be downloaded.
- Once the software update is completed, the system will automatically restart. If the system does not automatically restart, then power cycle the PLC control box.

Recording System Variables

TARE AND WEIGHT FACTOR

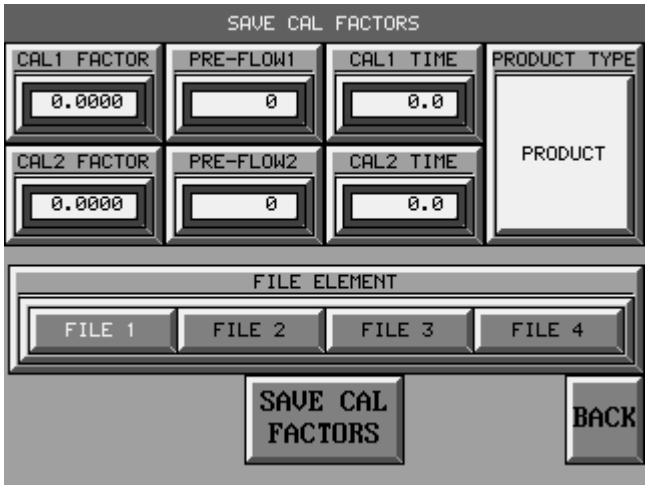
Navigate to 'Tune Amplifier/Tare Sensor' screen within the 'Initialization' screen.



Locate the 'Tare' and 'WT-Factor' values.
Record: TARE: _____ WT_FACTOR: _____ Date: _____

CALIBRATION VALUES

Navigate to ‘Save Cal Factors’ screen within the ‘Calibration Menu’ screen.



Navigate to the Field Calibration screen and select “CAL Master”.

Cal C1: _____ @ Pre-flow 1 _____ lbs/min @ Time 1 _____ seconds
Cal C2: _____ @ Pre-flow 2 _____ lbs/min @ Time 2 _____ seconds

TROUBLE-SHOOTING TIPS

SLOW OPERATION OR DELAYED SCREEN TRANSITIONS

If the operator notices that the system is experiencing a delay when changing between screens or operating slower than normal, consider power cycling the system.

- Unplug the unit from the 110 volt AC power supply (AVOID opening the enclosure).
- Wait 30 seconds.
- Plug the power cord back into the 110 volt AC power supply and observe if performance improves.

INCORRECT GROSS READING

If the tare reading does not reflect the expected reading, consider checking the connections between the PLC control box and the flow sensor(s).

- If the gross reading shows zero "0" with a standard weight (or full bottle of water), check the connection between the PLC control box and the flow sensor(s).
- If the gross reading does not change when a standard weight is placed on the sensor box/plate, and it has been verified that all shipping bolts (one top bolt and 2 bottom bolts) are removed, it is possible that a load cell is not functioning correctly. Contact your CADARO representative for further assistance.

UNRECOGNIZED FLOW RATE BY THE PLC

If the PLC is not recognizing the flow rate, consider the following:

- Ensure that the Integral flow sensor is properly connected.
- Check for any system restrictions that may be affecting the flow rate.
- If the issue persists, it could indicate a damaged load cell. Contact your CADARO representative for further assistance.

DATA SHARING ISSUES BETWEEN PLC AND SITE AUTOMATION SYSTEM VIA ETHERNET

To resolve issues related to data sharing between the PLC and a site automation system via Ethernet, follow these steps:

- Verify that the Ethernet connection is secure and properly connected.
- Check if the IP parameters at the location have changed and no longer match the CADARO PLC. You can use the IP configuration program from CADARO to investigate and adjust the settings accordingly. Although a newer version of the AVG IPConfig tool may exist, we recommended that ONLY version 1.0.2 (AVG IPConfig 1.0.2.exe) is installed/utilized to view and set IP addresses for external communication.

OPERATOR SCREEN ISSUES

If the screen on the PLC control box is not turning on, consider performing the following checks to ensure power is being provided to the unit:

- Verify that the unit is properly plugged into a 110 volt AC power source.
- If applicable, ensure the interruptible power supply has a visible green light (APC UPS units illustrate a green light under normal conditions). If the power supply is off despite proper connections, it may be faulty.
- If 110 volt AC power is being provided to the PLC control box, and the screen does not power up or respond to touch, there could be an issue with an internal component. Contact your CADARO representative for further assistance.

LOSS OF FACTORY SETTINGS DUE TO POWER LOSS

Values should remain so long as the PLC and HMI backup batteries are in working order.
If a power loss has resulted in the loss of factory settings.

- Replace both HMI and PLC batteries.
- Inspect the PLC door to locate the original factory settings. If unavailable, a new initialization and calibration needs to be completed.
- Manually input factory settings into the 'Manual Cal Factors' screen.

NO SIGNAL FROM FLOW SENSOR(S)

If there is no signal from the flow sensor(s), perform the following checks:

- Verify that the cable and connections are in good condition and securely connected on each end of the sensor cable.
- Contact your CADARO representative for further assistance.

NAN (NOT A NUMBER) VALUE

If you encounter a NAN value, which is seen when the code has been lost because of a power disruption (often associated with lightning strikes), please take the following steps:

- Record the C1 and C2 values along with their respective pre-cal flow rates.
- Power cycle the PLC by switching the breaker off for 30 seconds, then back on.
- Allow for bootup.
- Navigate to 'Save Cal Factors' screen within the 'Calibration Menu' screen.
- Check if the recorded values match the on-screen values.
  - If yes, the problem should be resolved.
  - If not, a manual 'Push Cal Factors' will need to be performed using the recorded values.
- Instructions for this can be found in 'Calibration Menu' section.

SERVICE AND REPAIR

CONTACT PHONE NUMBER AND EMAIL ADDRESS

For service or any questions regarding the product, please contact CADARO using the following details:

- Email: service@CADARO.com
- Phone: (806) 338-7478

WARRANTY

Warranty Voidance Notice: Please note that any alterations, repairs, or disassembly performed by unauthorized individuals or persons not authorized by CADARO are strictly prohibited and will result in the voidance of the warranty.

SPECIFICATIONS

PRODUCT WEIGHTS

Figure 56: Product Weights

MODEL	Low Operating Range (lbs/min)*	High Operating Range (lbs/min)*	Inlet/Outlet Pipe Size (diameter round/square)*	Configuration	Flow Sensor Dimensions (L x W x H)	Flow Sensor Weight (lbs)
INTEGRAL NR/2K | INTEGRAL NRL/2K	800	2,000	6" OD	Round	32 ⅛" x 13" x 11 ⅝"	67 | –
INTEGRAL NS/5K | INTEGRAL NSL/5K	1,750	5,000	9 ¾" x 9 ¾" ID	Square	30 ⅜" x 16 ¼" x 15"	135 | 200
INTEGRAL NS/20K | INTEGRAL NSL/20K	5,000	20,000	17 ¾" x 17 ¾" ID	Square	36 ½" x 23 ⅝" x 24 ¾"	210 | 275
INTEGRAL NS/50K | INTEGRAL NSL/50K	17,500	50,000	29 ¾" x 29 ¾" ID	Square	36 ½" x 37" x 35 ⅝"	375 | 425

**Operating range can be calibrated to measure lower flow rates but overall range and accuracy requirements need to be considered.*

SIGNAL OUTPUT VOLTAGE

Ethernet (standard) with Modbus option, and/or 4 channel analog outputs with 0-5 VDC, 0-10 VDC (optional)

PLC CONTROL BOX

12.8 lbs. for single channel

POWER RATING

1.3 amps at 110VAC

RATED CAPACITY

The table below lists the acceptable flowrates (lbs/min) for 4 common models.

Table 6: Flow Sensor Specifications

Model	Measurement Range Lbs/Min	Measurement Range Kg/Minute [1]
Integral NR/2K	800-2,000	400-1,000
Integral NS/5K	1,750-5,000	800-2500
Integral NS/20K	5,000-20,000	2,300-9,100
Integral NS/50K	17,500-50,000	8,000-22,700

REQUIRED POWER AND SUGGESTED UPS

The PLC Control box requires a 110VAC and Un-interruptible Power Supply (UPS) [recommended] along with spike free, steady voltage. Electrical components may not be covered under OEM warrantee if a quality UPS is not used to power the system. It is further recommended that a professional licensed electrician (or other experienced / qualified individual) evaluate the quality of the original power supply to ensure that spike-free, steady is being supplied to the UPS and to the PLC Control box.

FLOW SENSOR DIMENSIONS

Figure 56: Integral NR/2K

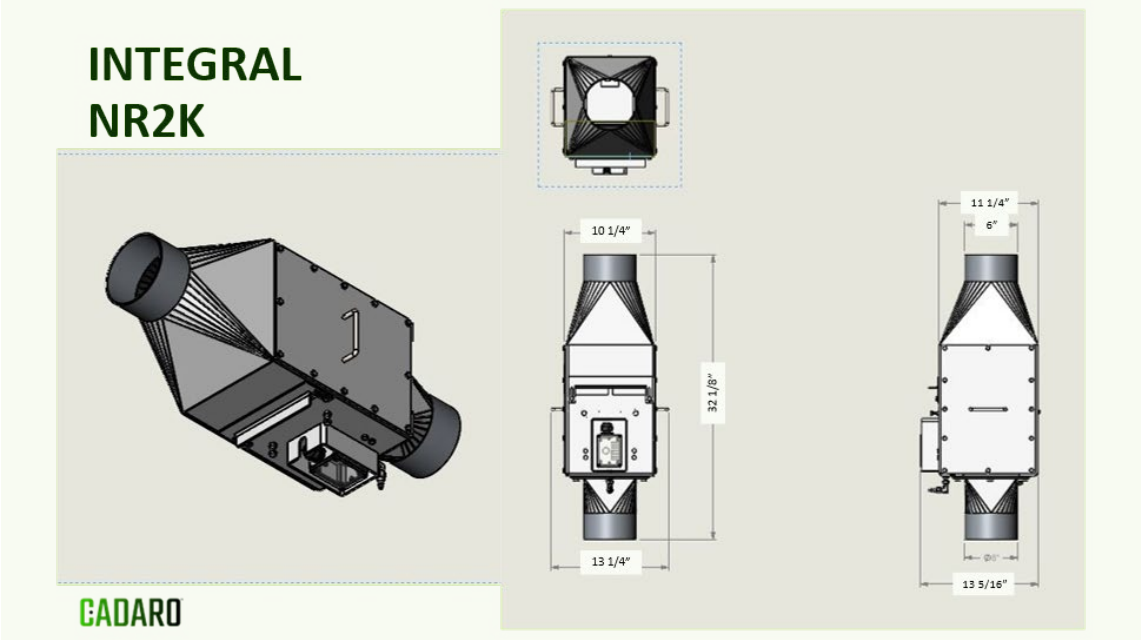


Figure 57: Integral NS/5K and NSL/5K

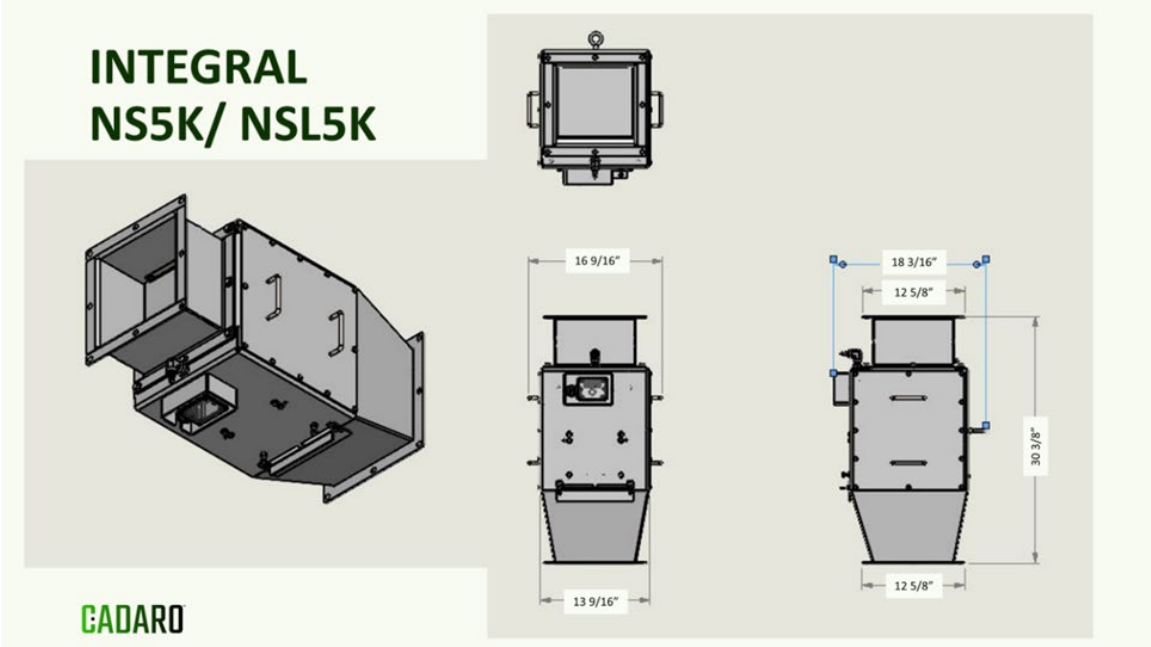


Figure 58: Integral NS/20K and NSL/20K

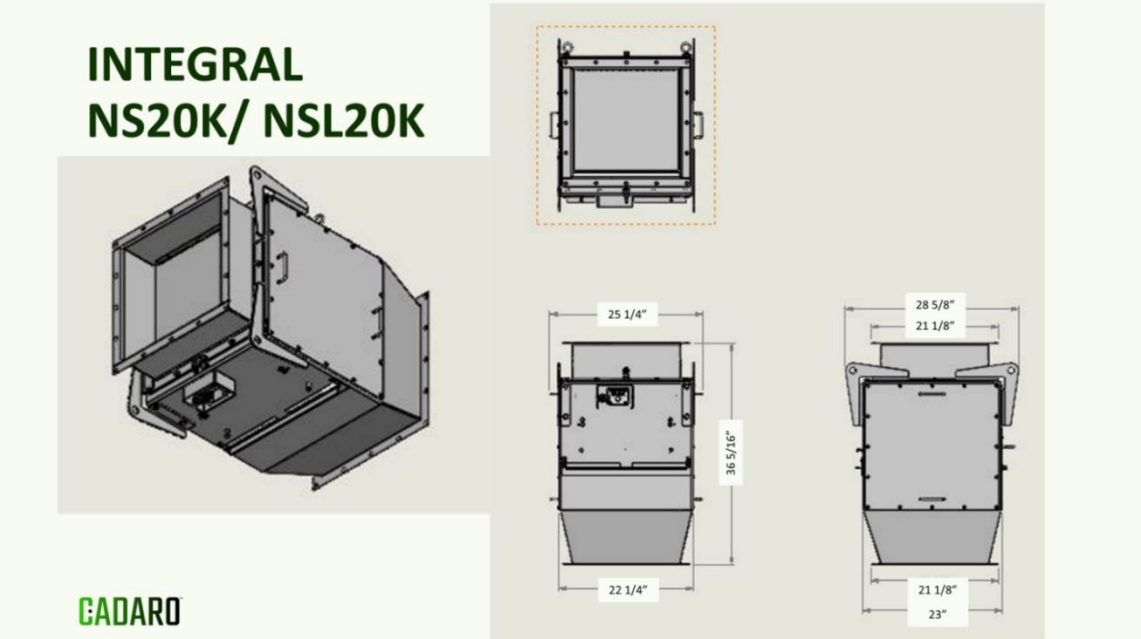
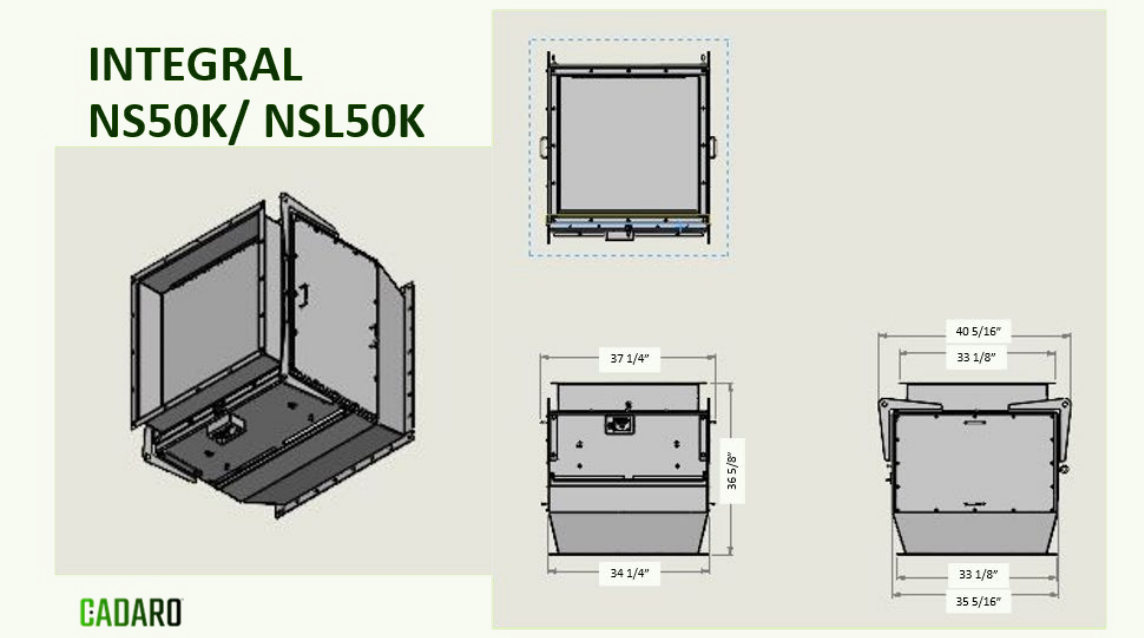


Figure 59: Integral NS/50K and NSL/50K



INTEGRAL FLANGES

Figure 60: Integral NS/5K and NSL/5K Flange Detail

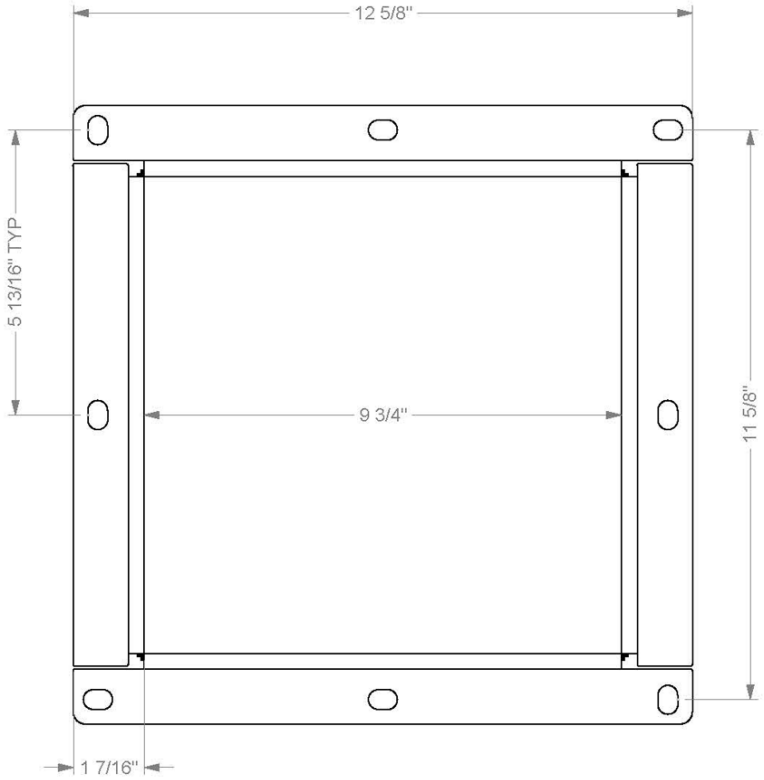


Figure 61: Integral NS/20K and NSL/20K Flange Detail

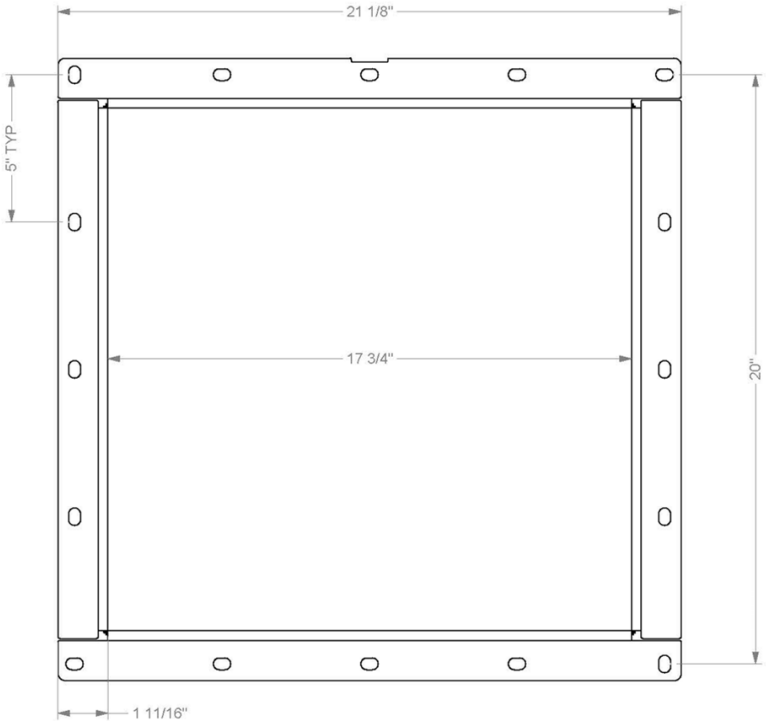
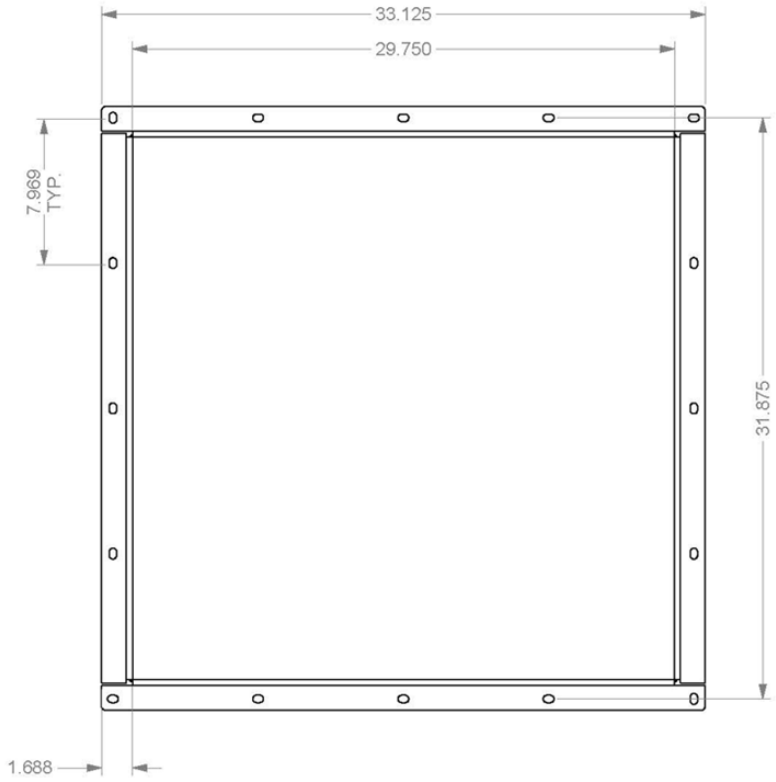
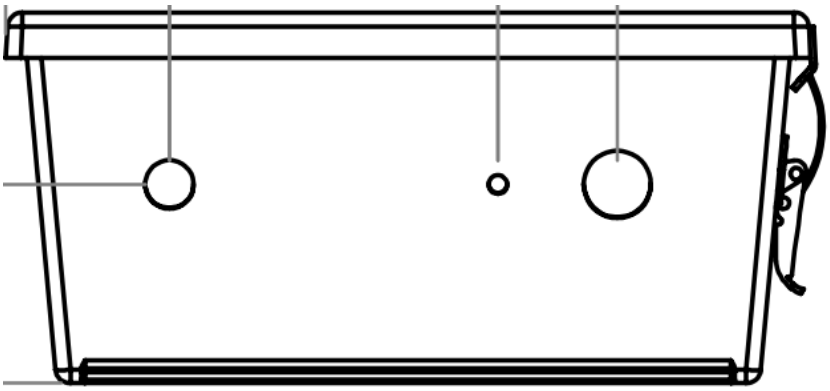


Figure 62: Integral NS/50K and NSL/50K Flange Detail



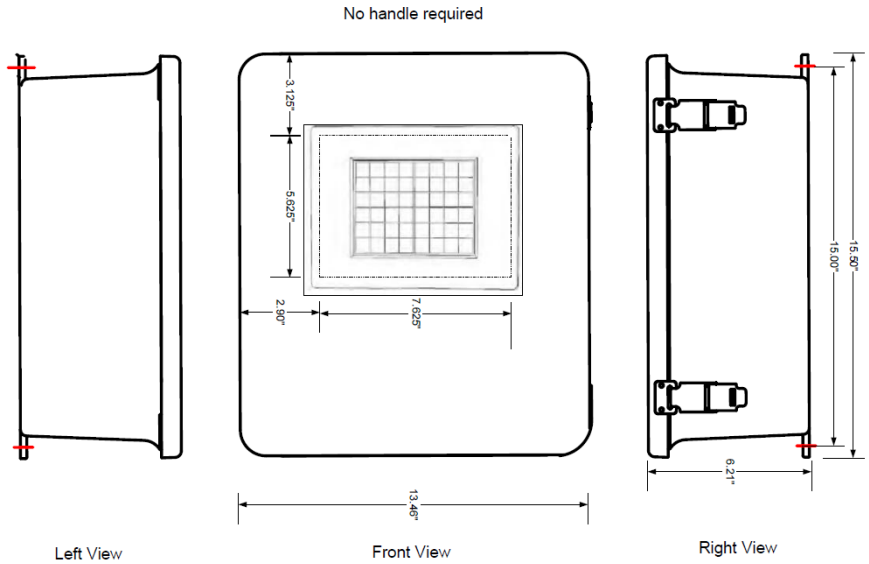
PLC CONTROL BOX DIMENSIONS

Figure 63. PLC control box Enclosure with 6-inch HMI



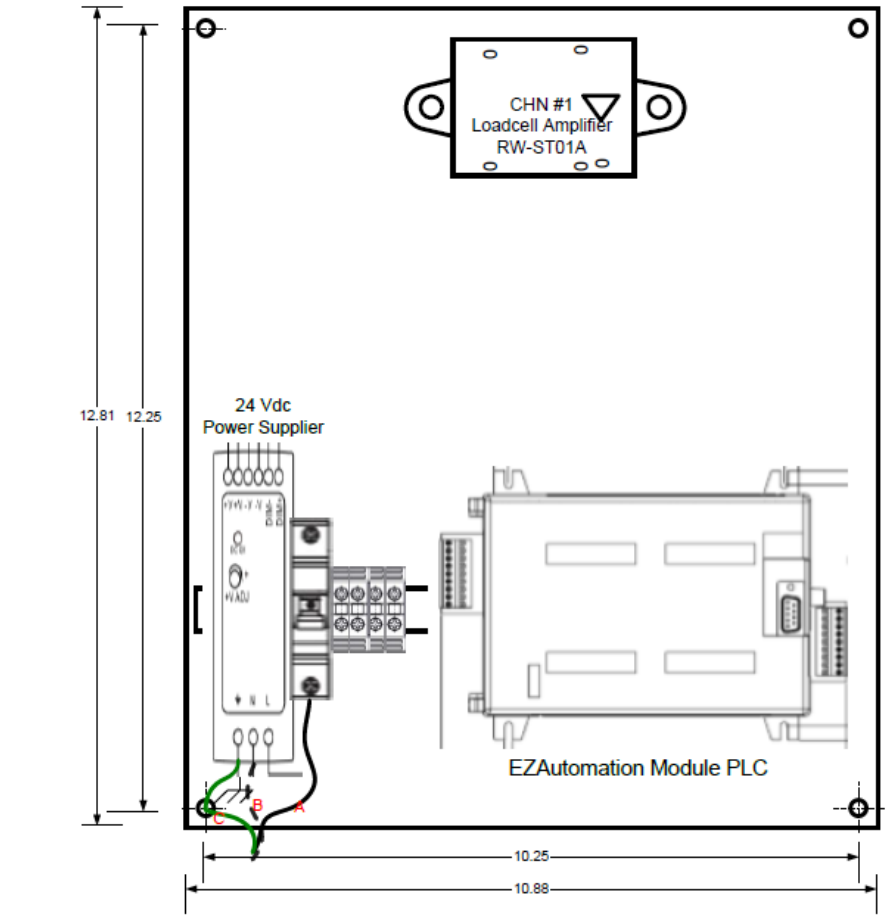
Note: Pre-site assessment will determine the recommended sensor.

The power supply hole is in place for site installation to hard wire the PLC control box to the electrical supply. The site will need to drill the exact hole size to meet their conduit or other installation requirements.



PLC WIRING DIAGRAM

Figure 64: PLC Wiring Diagram



Location Power Supply
A – Black wire to the circuit breaker
B – White wire to power transformer
C – Ground to the metal PLC panel

BATTERY REPLACEMENT GUIDE: HMI AND PLC BATTERIES

It is recommended that both batteries are replaced every 3 to 5 years, or when a battery alarm appears.

Reloading calibration profile after battery replacement:

- A partial RAM memory will be wiped when a battery replacement is performed on the HMI.
- *All RAM memory will be wiped* when a battery replacement is performed on the PLC.
- If either battery is replaced, or both, there needs to be some preparation beforehand to ensure smooth recovery to full function.

HMI Battery Pre-Replacement Preparation:

1. On the HMI, navigate to 'Flow Sensor Menu'.

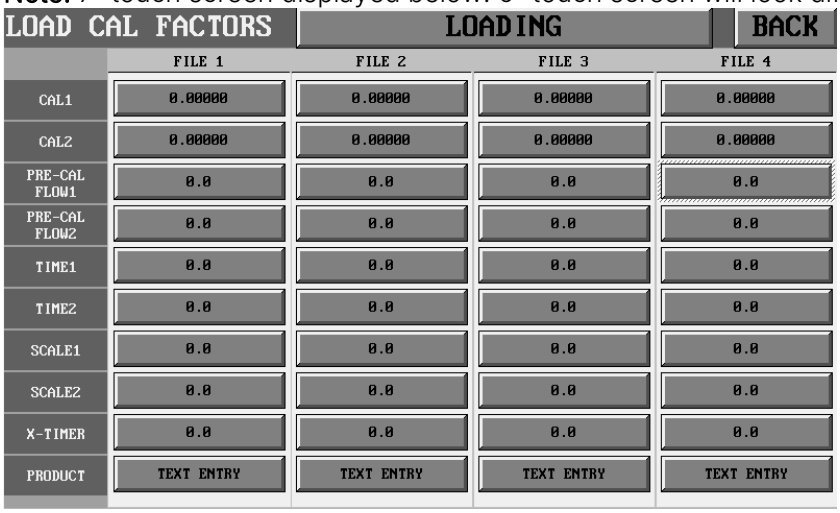
   Take a picture or write down the 'Flow Sensor Characteristics' values of 'Active Model Type', 'Active Model Range', and 'Lined?'.

   Note: 7" touch screen displayed below. 6" touch screen will look different but function the same.

   'Lined' may or may not be visible. It depends on your specific model installed.

Navigate to the 'Load Cal Factors' screen. Take a picture or note down the values populated in each File.

Note: 7" touch screen displayed below. 6" touch screen will look different but function the same.



2. After the battery/s have been replaced and the system reinitialized, input the saved calibration profile values to the respective calibration file.
3. To load the profile, select the file at the top of the column. The selected file will be white, while the others are gray.
4. Press 'Load Cal Factors' button at the top.
5. The unit will be back to functioning as before. If not, contact Cadaro Support.

HMI Battery Replacement Procedure:

1. Power down the unit by turning the breaker off.
2. Access HMI battery by opening the cover. There is a press-to-open latch opposite the pivot hinge.
3. The battery is near the pivot hinge.

4. Remove the battery and replace it with a new battery. Be sure to follow positive (+) and negative (-) installation instructions on or near where the battery is installed.

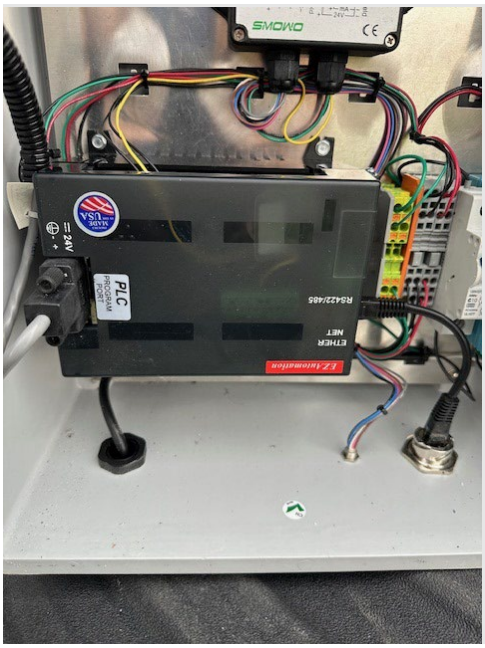
5. Power on the unit by turning the breaker on.
6. **Caution:** Do not touch any equipment or wires while power is applied.

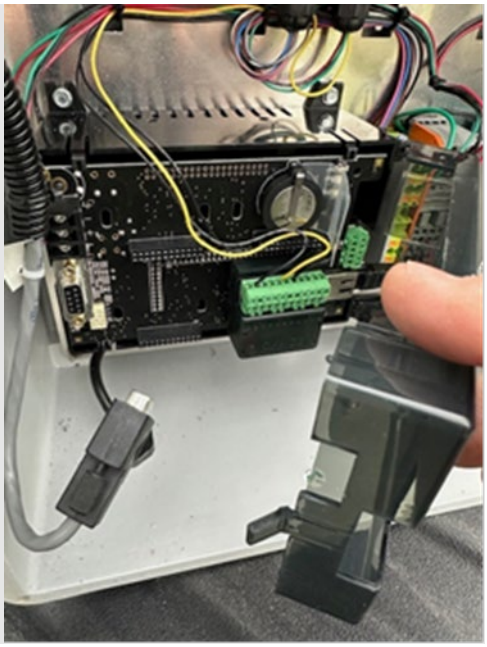
7. Wait a maximum of 30 seconds for HMI panel to power up. If HMI does not power up, power down the system again by turning the breaker off. Wait 30 seconds. Power up the unit again by turning the breaker on.
8. If still no bootup from the HMI, try 6.a -6.c again.
9. If still no bootup, double check the battery installation is correct.
10. If still no bootup, contact Cadaro Support.

HMI Battery Specifications: LS14250 3.6 Volt 1200 mAh PLC Lithium 1/2AA Battery

PLC Battery Replacement Procedure

1. Power down the unit by turning the breaker off.
2. Access PLC battery by opening the cover. There is a press-to-open latch opposite the pivot hinge.
3. The battery is near the pivot hinge.





4. Remove the battery and replace it with a new battery. Be sure to follow positive (+) and negative (-) installation instructions on or near where the battery is installed.
   *The PLC battery can be difficult to remove. It is suggested to use a small flathead screwdriver to pry up the pressure clip while using a second small flathead screwdriver to push the battery out.
5. Power on the unit by turning the breaker on.
6. **Caution:** Do not touch any equipment or wires while power is applied.
7. If the screen does not power up, refer to point 6 in the HMI battery replacement section.

PLC Battery Specifications: CR2032 3-Volt Battery

CADARO LIMITED WARRANTY

M&S Flowmatics Incorporated, doing business as CADARO, ("CADARO") warrants that all CADARO equipment properly installed by CADARO, or its Distributor or Original Equipment Manufacturer (OEM) will operate according to the written product specifications. CADARO, its Distributor or OEM, at CADARO sole option may determine whether the product fails to meet its specification. Should a Distributor or OEM determine the product fails to meet its specification, it shall submit the claim to CADARO. CADARO must review the determination and accept the claim. All systems and components are warranted against defects in electronic equipment and defects in material/assembly for one (1) year beginning with the delivery date.

CADARO warrants the equipment against faulty workmanship and defective materials. If any equipment fails to conform to these warranties during the warranty period set forth above, CADARO will, at its option, repair or replace the non-conforming portion of the product returned within the warranty period subject to the following conditions:

- Upon discovery by Buyer of a nonconformity and provided such discovery is within the warranty period, Buyer will provide CADARO with prompt written notice within 30 days and provide a detailed explanation of the alleged deficiencies.
- Upon examination of the equipment CADARO will determine whether the equipment fails to meet its specifications consistent with the Operations Manual and such failure was not the result of accident, abuse, welding, misuse, neglect, alteration, improper installation, or improper testing by Buyer or any third party authorized by Buyer. Such determination of any alleged non-conformity shall be made in good faith; however, such determination shall be CADARO' sole and exclusive determination.
- Only CADARO or a party authorized in writing is authorized to make any repairs. The equipment may not have been modified, altered, or changed by any person other than CADARO or a party CADARO authorizes to make the repair, or the warranty shall be void.
- CADARO will have a reasonable time to repair or replace defective equipment. The buyer is responsible for shipping charges to and from CADARO's designated location.

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"Patent": www.cadaro.com

RECOMMENDED INFORMATION TO BE STORED IN PLC CONTROL BOX

Information

Date	
Serial Number Flow Sensor	
Serial Number PLC Control Box	
Load Cell Tare	
Wt. Factor	
Lined or Unlined Sensing Plate	
Auto Retare	
Dead Zone	
Software Version	
IP Address	
Subnet	
Gateway	
HMI IP Address	
Amplifier IP Address	

Calibration

	File 1	File 2	File 3	File 4
CAL1				
CAL2				
Pre-Cal Flow1				
Pre-Cal Flow2				
Time1				
Time2				
Scale1				
Scale2				
Product				

service@CADARO.com 806-338-7478