



**Integral™ Series (Flow Sensor and PLC)
OPERATIONS MANUAL**

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U.S. Pat. 9,354,092 B2, 6,805,014 and 6,973,843 – Other Patents Pending
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1. Product Description

1.1 How the Integral Series Flow Sensor Works

The Integral flow sensor from CADARO is designed to measure the real-time flowrate, batch weight, and total accumulated weight of dry granular products. Utilizing advanced load cell signal processing technology, the flow sensor is often installed in-line within or at end of 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 (Contact CADARO service for directions).

1.2 Best Suited Applications

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

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

1.3 Limitations

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

1. Situations involving non-uniform material flow or materials with a long drop, leading to excessive material velocity.
2. Environments experiencing abrupt changes in temperature or material moisture, which can affect the accuracy of measurements.
3. Installation sites subject to excessive motion, vibration, or exposure to electronic and mechanical shocks.
4. Outdoor installations or locations with ambient temperatures below 20°F (-6.7°C) or above 120°F (49°C).
5. Applications requiring NTEP certification for legal trade purposes.
6. 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.



2. Integral Series Flow Sensor Assembly and Installation

2.1 Before Installation

1. 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.

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 1/8" x 13" x 11 5/8"	67 -
INTEGRAL NS/5K INTEGRAL NSL/5K	1,750	5,000	9 3/4" x 9 3/4" ID	Square	30 3/8" x 16 1/4" x 15"	135 200
INTEGRAL NS/20K INTEGRAL NSL/20K	5,000	20,000	17 3/4" x 17 3/4" ID	Square	36 1/2" x 23 5/8" x 24 3/4"	210 275
INTEGRAL NS/50K INTEGRAL NSL/50K	17,500	50,000	29 3/4" x 29 3/4" ID	Square	36 1/2" x 37" x 35 5/8"	375 425

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

2. 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:

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.

Note: If the shipping bolt is tightly secured, apply pressure to the bottom of the inner square sensing box to remove it.



2. 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.

Lower the bottom shipping bolts by following these steps:

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 yellow Turck cable.

1. Connect the male end of the load cell cable (30 or 75 meters) to the Integral flow sensor junction box and the female end to the to the PLC control box.
2. Go to the Loadcell Setup screen by pushing “Loadcell Setup” from the “Main Menu” and press “Zero” to ensure the gross and tare weights are the same and the net weight is zero. Apply slight pressure to the interior sensor box and watch for weight to begin accumulating, indicating successful communication with the load cells.
 - a. If the weight factor is zero or if the load cell weight is zero or 4095 then refer to section 4.3 pre-setting

System Confirmation with Weight

1. Place a small weight, such as a standard 500 or 1000 gram weight, into the sensing box.
 - a. 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.
 - a. If this does not occur, please contact CADARO as it is possible that your sensor has been damaged during shipment.



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*

2.2 Sensor Installation

Best Practices / Guidelines:

A manual gate or choke immediately upstream or downstream of automatic gate will ensure consistent and repeatable flow.

Certain system configurations may require the inclusion of gate/choke immediately upstream of the flow sensor.

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.

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 makes contact with the internal sensing box. 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 box 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.

2.3 Post-Installation

After a 30-minute waiting period, press the "START" button and enter the password (a 4-digit number provided by CADARO).

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 warranty. Refer to section 10 for further details.

3. PLC Control Box Installation

3.1 Box Location:

Choose a safe, dry, and convenient location to mount the PLC control box. For optimum performance ensure that the location is within 100 feet of the Integral flow sensor to allow the Integral flow sensor output cable to reach the box. Connect the Integral flow sensor signal output male connector to the PLC control box female input connector. It is important not to cut, splice, or alter the Flow Sensor cable or connectors.

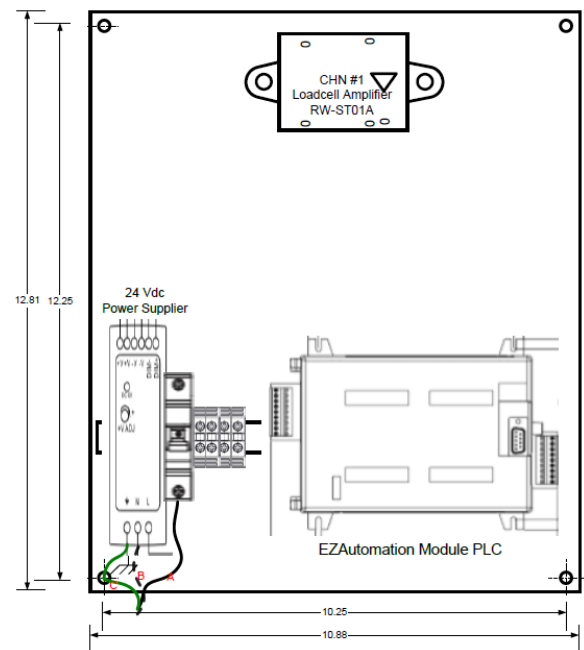
Important: Avoid placing the PLC control box in direct sunlight. Treat the PLC control box with the same care as a computer and avoid placing it where it will be exposed to less than ideal conditions. CADARO recommends placing the control box inside a building or, if that is not possible, in its own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

3.2 PLC Control Box Power Requirements:

The PLC control box is designed to be plugged into a standard outlet.

3.3 PLC Output Description:

For installations with an existing automation system, the Integral flow sensor signal can be managed and delivered through the PLC. The PLC control box output signal can be integrated into your current system using the standard Ethernet (Modbus) connection. Our data outputs, such as flow rate (lb/min), batch weight (lbs), and total weight (lbs), are saved with registers accordingly.



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

3.4 PLC Output Pin Assignment: The connector used is a standard RJ45 Ethernet connector.

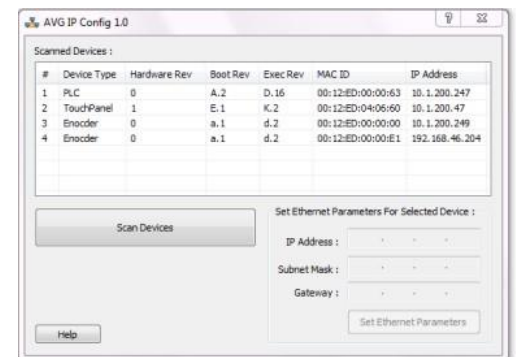
3.5 PLC IP Address

1. Record the settings you currently have on the Main Menu > Field Calibration > Master Cal page.
 - a. If a previous calibration has been made, the picture will allow you to “plug in” the F. R. lb/min and C value, meaning you will not have to recalibrate if settings are lost while resetting the IP settings.
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.
 - a. 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.
 - b. If there is no ethernet cable between the RJ45 and the PLC component, plug directly into the ethernet jack on the PLC component.

4. Make sure all devices are powered on.

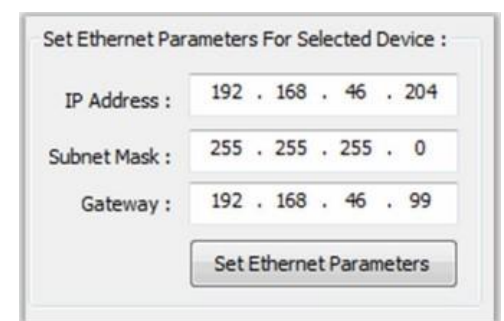
5. Install and Open the IP configuration program on your PC and click on "Scan Devices."

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



6. 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.

- a. Typical private network ethernet parameters example:



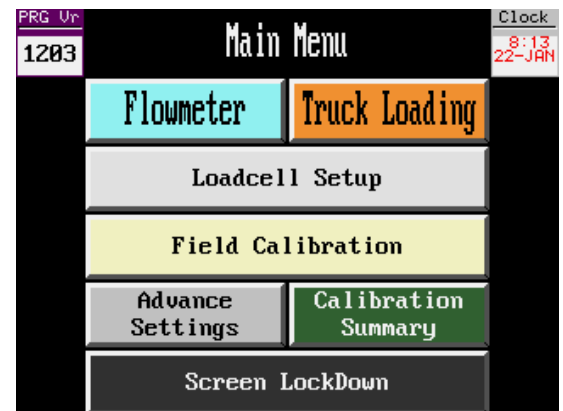
IP Address	192	168	1	X
Subnet Mask	255	255	255	0
Gateway	Empty			

7. After configuring Modbus communication with your plant PLC, check if you can see the flow rate, batch information, and total weight from your system.
8. If you can't view the information, double-check the IP settings to ensure they are correct.
 - a. If you still can't view the information, try restarting the PLC control box to activate the new IP address.
9. 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.

4. Start-up Instructions

4.1 Main screen after Initialization

After the system is initialized, the start screen will be displayed. During the initial use, certain basic steps such as SETUP and CALIBRATION need to be completed.



4.2 Start-up Instructions:

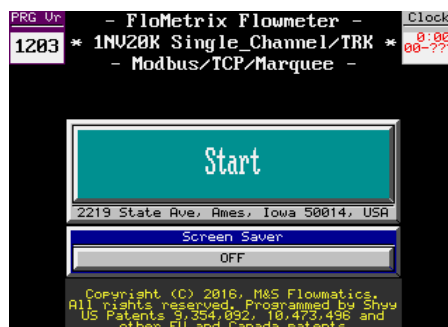
1. Connect the male end of the cable to the sensor and female end to the cable PLC control box.
2. Plug in power cord to outlet
3. Open the panel on the PLC control box and turn on the power from the circuit breaker.

4. The PLC will initialize and load the software. While the PLC is completing its diagnostics, the HMI display will show system information for the panel HMI.
5. After the system is initialized the start up screen will display
6. Click start, enter security code 9999, click enter. Then you will see the Main Menu Screen.
7. The Main Menu will be displayed. Proceed to complete / verify SETUP prior to calibration.
8. First check the PRG Vr '9999' (in the upper left corner of the Main Menu), which indicates that the PLC is still initializing.
 - a. The PRG Vr (program version) should update to its current value.
 - b. Please wait for it to change from the 9999 value to a number like: 0412 or 061223
9. Ensure that the Integral flow sensor is powered on for at least 30 minutes to allow the load cell(s) to stabilize after being connected to power and the PLC control box.

4.3 Presetting:

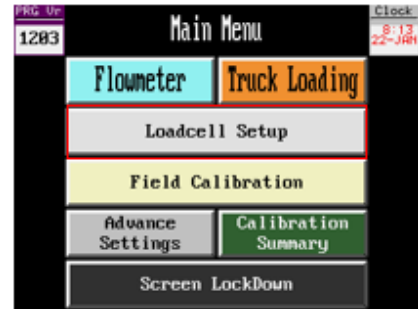
Ensure that the PLC control box has been turned on and connected to the sensor for a minimum of 30 minutes before proceeding.

1. Press the "Start" button.
 - a. The default code is 9999.



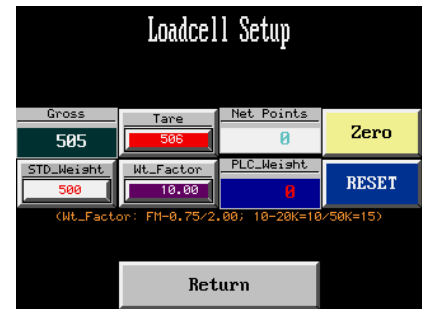
2. Navigate to "Loadcell Setup."

- a. Look at the gross section, the load cell gross should NOT be zero or 4095.
 - o If the load cell gross shows zero or 4095, check the connections between the PLC control box, cable, and sensor.
 - o Click zero
 - o The gross value and tare value should be equal or within 1-2 points after zeroing out. (Contact CADARO service if the gross is not within 500-1250)



3. A static weight test can be completed to verify that the PLC is receiving a signal from the flow sensor.

- a. From the Main Menu screen, select "Loadcell Setup."
- b. First, check the gross and tare. If the gross value is zero, it means the sensor is not currently reading a signal. Ensure that the shipping bolt (Integral-2 shipping bolts) and shipping spacer has been removed, and the cable is properly connected between the PLC control box and the sensor.



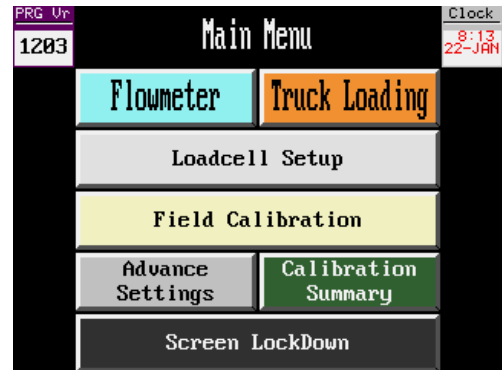
- c. Next, press the "Zero" button to set the tare value to match the current gross with no material running.

If a static mass (weight) was placed on the sensor, remove the mass, and check gross and tare.

4. The Wt_Factor should not be zero. Refer to chart to confirm Wt_Factor is correct on screen based off the values below

Model	Weight Factor
Integral NR/2K	5.00
Integral NS/5K	5.00
Integral NS/20K	10.00
Integral NS/50K	15.00

5. Press "Return" to Main Menu
6. Navigate to "Advance Settings." Enter security code 9999 and click enter



7. Select "Advance Settings."
 - a. The screen will display the Integral Model Number, Batch(Unit), and other manufacturer settings.
 - b. Use the Date/Time Editor to change the TIME and date if needed.
 - i. Click Date/ Time Editor
 - ii. Fill out correct year, month, day, hour and minute.
 - iii. Click Return once completed.



8. Press "Xtimer" to set the sampling timer.
 - a. From the Advanced Settings screen, Press Xtimer on "GO"
 - b. Press "Reset" under "System Reset."
 - c. Press "Start."
 - d. The button will change to "Counting, please wait."
 - e. If the PLC seconds is between or equal to 25.0 and 25.9, you may proceed to calibration.
 - f. If the PLC seconds is outside the range of 25.0-25.9, press "Tune."
 - Press "Reset."
 - Press "Start."



1. The PLC seconds should be 25.0-25.9

- Return to the "Advance Settings" screen, and verify the Model CH1 is correct for your application:

2K = 2000; 5K =5000, 20K=20000, 50K=50000

Enter a batch weight (if desired) in the "Batch (Unit)" input box. A batch value cannot exceed 9,999,999

Once the selections have been reviewed, return to the Main Menu (Menu "Return" button bottom of the screen)

10. AUTO TUNE ON/OFF

NOTE: The Auto_Tune function is designed for systems with instant start/stop "plug" flow. The Auto_Tune function can be turned off for systems that do not produce plug flow. For a system that experiences gradual increases (or decreases) in flow rate, it may be desirable to turn off the Auto_Tune function. The Auto_Tune function has adjustable settings designed to reduce the impacts of quasi steady-state environmental conditions (like vibration).

- To turn on/off the auto tune navigate from Main Menu>Advance Settings
- Press the button under Auto_Tune labeled "TARE-CHK"
- Turn auto tune either on or off: ON-green and says on OFF-red and says off

11. Adjusting the auto tune

- The default SENS setting is a 4. The smaller the value, the more sensitive your equipment will be. If the tare value is fluctuating a significant amount, it may be beneficial to increase the value of the Auto tune so that it will change less often.
- IF AUTO TUNE IS OFF YOU WILL HAVE TO TELL THE OPERATORS TO MANUALLY TARE THE MACHINE FROM THE PLC CONTROL BOX BOTH BEFORE AND AFTER THEY RUN.

- The "Bline" value is used to adjust for vibration. Navigate from Main Menu --> Advance Settings. The default "Bline" value is 20.

- Turn on all equipment which MAY BE running when the sensor is in operation and run any adjoining equipment/processes that MAY cause vibration on the sensor.
- Click return to Navigate the Main Menu then click Flowmeter, Click RST on the right-hand side and



- observe the accumulation of Batch weight for 1 minute.
 - c. If weight is accumulating with no product running, return to Main Menu, click Advance Settings, enter security code 9999. Click Bline (20) increases the "Bline" from current value to +10.
 - d. Continue increasing the "Bline" value in increments of 10 until the accumulation of weight illustrated on the "Flowmeter" screen stops. Observe for 1 minute.
 - e. If the weight value on the "Flowmeter" screen has stopped increasing (no more accumulation), navigate back to "Advance Settings."
13. From the "Advance Settings" screen, verify the "C2-Offset" is 0.250 and the "AG_Correct" is default values of 1.000 [PRIOR TO CALIBRATION].

5 Calibration

5.1 System Calibration

Please Note: It is recommended to use a standard sample size that matches what you will be measuring. For example, if you want to measure a truck, run a sample equivalent to the size of a truck. The longer the sample run matches the actual flow being measured, the more accurate the calibration will be. Also, run your sample where the majority of your flow rates occur.

1. From the Main Menu, press "Field Calibration."
2. Press "ZERO" under "Reset Batch" located at the bottom left of the Field Calibration screen.



3. Run a sample at a consistent flow rate.
 - a. The longer the sample calibration is run, the better the accuracy.
 - b. To get the best accuracy it is recommended to run the commonly used/desired target volume for calibration.
 - c. The "PLC Reading", the "Timer", and the "AVG FR (lb/m)" [default (lbs/min)] will automatically start accumulating values.



4. Weigh the mass that passed thru the sensor, or take the pre-weight value of the sample, and enter the actual/real weight value under "Scale Reading"
5. Press "Tune" or "Cal High."
 - a. The values in "FlowRate (Per Min)", "WT-CAL-01", and "CAL-Realtime" should all change accordingly.
6. Press "Zero" under "Reset Batch", and run three additional samples at same gate opening/flow rate as calibrated to ensure calibration is within desired accuracy.
 - a. If the calibration is not within the desired accuracy, repeat steps 2-5 or contact CADARO for assistance.

Steps to Save Record

1. Once calibrated go to Advances Settings, go to record name and record the Records name
 - a. Example RECORD 1 CORN
2. Click return
3. Click Field Calibration Page
4. Click Save to "RECORD #1," "RECORD #2," "RECORD #3" "RECORD #4"
5. Click Return and go to Calibration Summary and enter security code 9999
6. Ensure the record is saved correctly

Note: It is recommended that operators document calibration values. Please fill out the table below or email the values to info@cadaro.com

Date	Name	Flowrate (lbs/min) Cal 1	Cal C1 Value	Flowrate Cal 2	Cal C2
07/24/23	Example: Corn	2500	1.5123	2200	1.2123

Low Flow Rate Calibration:

It is recommended that a flowrate used for a second (often thought of as a "LOW") flow calibration to calculate/set a C2 value be AT LEAST 20% less than the flowrate used for the single point (a.k.a "HIGH") flow calibration to calculate/set the C1 value

1. Choose a flowrate that represents the lowest consistent flowrate that the sensor will experience.
 - a. The flow rate should not be 0 lbs/min.
2. Press "Advance Field Cal" or "CAL Master." to move to the "FIELD_CALIBRATION CHN #1 (lbs)" screen.

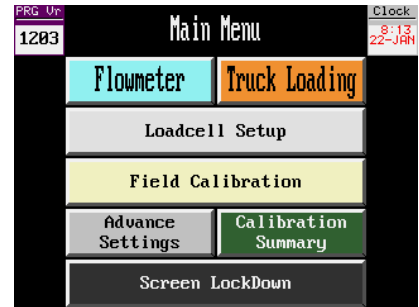
CAL Master			Field Calibration		Date
PLC Reading	Scale Reading	FlowRate (Per Min)	Calibrate C1		
0	9999	9999	CAL (High)		
WT-CAL-01	CAL-Realtime	Timer	AVG FR (lb/m)		
1.0000	-1.2384	0.0	0		
SAVE TO RECORD #1	SAVE TO RECORD #2	SAVE TO RECORD #3	SAVE TO RECORD #4		
Reset Batch Zero	Return		Goto Low_Cal		

3. Press "LOW" found on the left side of the screen under "CAL C2" to move to the FIELD CAL, CHN #1 <LOW FLOWRATE> screen.
4. Press "Zero" under "BATCH WEIGHT."
5. Run a sample that represents the consistent low flow rate.
 - a. The longer the sample calibration run, the better the accuracy
 - b. The "PLC WT (lb)" , "TMR (SEC)", and "AVG FR" (lbs/min) will automatically start accumulating values.
6. Weigh the mass that passed through the sensor, or take the pre-weight value of the sample, and enter the real weight value under "SCALE WT (lb)."
7. Press "DO CAL 1-2."
 - a. The "F.R. (lb/m)" "WT-CAL-02," and "Wt-CAL-RT" - should change accordingly.
8. Press "Zero" under "Reset Batch" and run three additional samples at the same gate opening/flow rate as calibrated to ensure the calibration is within the desired accuracy.

If not within desired accuracy, please run steps 4-7 again. Contact CADARO regarding any issues.

6 Operating Instruction

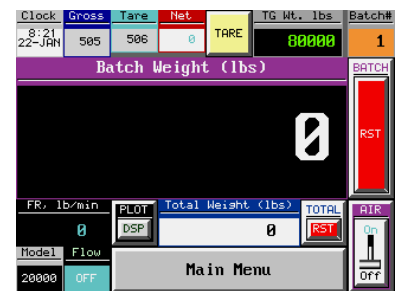
To begin operating the system, select "Flowmeter" from the Main Screen.



6.1 Single Channel Operations

The Single Channel Operation screen allows the operator to monitor flowrate ("FR, lb/min"), "Total Weight (lbs)", and "Batch Weight (lbs)".

Resetting the PLC for a new run can be done by selecting "RST" under BATCH to reset the batch only or "RST" under TOTAL to reset all values, including Batch Weight, Batch #, and Total Weight in the system.



Note: The operator can change the default display for weight units by selecting "To_KG" or "To_LB" in the lower left corner.

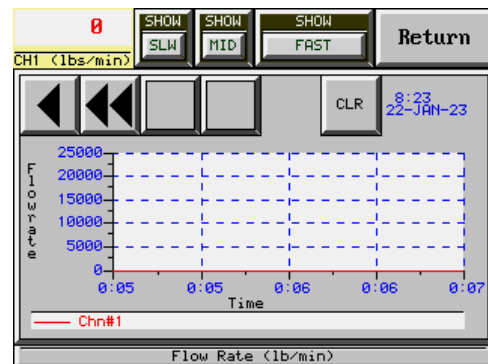
6.2 Single Channel Charting

The operator screen features graphing capabilities with a histogram.

To view the information, select the "DSP" button under PLOT.

To return to the operations screen from the charting screen, select "Return" in the top right corner.

See the example histogram below:





6.3 System Reset

The system reset function is used to restore the system to its original manufacturer settings. It is recommended to perform a system reset in the following situations:

1. When the system is not performing as expected
2. When there are incorrect settings
3. When there was extended power outages/surges or lightning strikes that caused erratic or lost information.
4. After loading new software

If the system was previously set up and operating effectively, it is recommended that the user capture the settings and store inside PLC control box for future use before resetting the system.

The following procedure outlines a hard reset and provides spaces to record key system values.

UPLOADING PROGRAM WHEN Cal C1 and Cal C2, and Other System Values are Known.

1. Contact CADARO for support in reloading the program.
2. Ensure that the flow sensor is connected to the PLC and powered up before proceeding.
3. Take a picture or notes of the calibration screen to document the values for flow rates, Cal 1/Cal 2 values. Then, select the button titled "CAL Master" in the upper left corner of the "Field Calibration" screen and capture the "Field Calibration CHN #1 (lbs)" screen. Additionally, take a photo of the "Loadcell Setup" screen in case the "WT_Factor" is required.
4. Open the enclosure and ensure that the panel is fully opened.
5. Load the new PLC software.
 - i. Locate the USB port on top of the HMI (within the enclosure).
 - ii. Plug in the USB containing a single .hmi file (CADARO software).
 - iii. Please note, the CADARO software CANNOT be in a folder when plugged into the HMI, or the HMI will be unable to view the document.
 - iv. From there follow step 6 and continue the upload process
6. Once the .hmi file is illustrated on the screen, push "Accept". The program will begin loading and screen will temporarily go black and then return to a normal operator view of the Main Menu screen.



7. Once the software update is completed, the system will automatically restart. If system does not automatically restart, then power cycle the PLC control box.
8. Navigate from the "Main Menu" to the "Advance Settings" screen.
9. Ensure that the Date/Time and Xtimer are correctly set. Press the "Reset" button located under the System Reset heading to activate the program functionality.
10. Return to the Main Menu" screen and access the "Loadcell Setup" screen.
11. In the "Loadcell Setup" screen, press the "ZERO" button for taring (to make Gross = Tare) to set the Net Points value to 0. Then, check the "Wt_Factor" and enter the value captured from your photos or notes. Press "ENTER."

Record: **TARE:** _____ **WT_FACTOR:** _____ **Date:** _____

12. Navigate to the Field Calibration screen and select "CAL Master".
13. C1 Value – select the box below the F.R. lb/min heading and enter the flowrate. Next to the box under the C Value heading, enter the C value corresponding with the flowrate. Repeat the same for the flowrate and C2 value for Cal C2

Field Calibration Channel 1 (lbs): _____
Cal C1: _____ @ flow rate _____ lbs/min
Cal C2: _____ @ flow rate _____ lbs/min
14. Navigate to the Main Menu, press the "Flowmeter" button, and select "RST" under Total to reset the Batch Weight, Batch #, and Total Weight values.
15. Close the door and secure the side locks on the enclosure.
16. The system is now ready for use. It is recommended that the user verify the accuracy of the system and test the calibration (re-inserted previous C value(s)) to fully leverage the system's capabilities and ensure accuracy.

6.4 Air System Installation- Internal Air System

If the material has a high amount of dust or breakage, this could cause a large amount of dust and material to accumulate in the sensor and could have a negative effect on accuracy over time. CADARO recommends frequent cleaning with air (often requiring 100+ psi and a large enough reservoir to hold at least 30 seconds worth of air to clean the sensor after each batch. If the material is clean this may not be necessary;



however, grain systems may require cleaning after each load. Contact CADARO regarding air for existing or new systems if required.

7 Trouble-Shooting Tips

7.1 Slow Operation or Delayed Screen Transitions

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

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

7.2 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).

1. 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).
2. 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), it is possible that a load cell is not functioning correctly. Contact your CADARO representative for further assistance.

7.3 Unrecognized Flow Rate by the PLC

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

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

7.4 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:

1. Verify that the Ethernet connection is secure and properly connected.
2. 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.



7.5 Data Illustration Issues (KG or LBS)

To address difficulties in illustrating data as KG or LBS, follow these steps:

1. Select the channel or channels screen.
2. In the lower left corner, locate the "CHG to" button and press it to modify the display units.

7.6 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:

1. Verify that the unit is properly plugged into a 110 volt AC power source.
2. 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.
3. 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.

7.7 Changing the Batch Size

To change the batch size for the measuring process, follow these steps:

1. Go to Advance Settings --the Setup Screen and select "Batch (unit)"
2. Enter the desired batch size, such as 50,000 or 65,000 pounds, or the equivalent KG value. Press "Enter" to confirm.
3. Once the entry is complete, reset the TOTAL WEIGHT on the flow meter screen.

7.8 Loss of Factory Settings due to Power Loss

If a power loss has resulted in the loss of factory settings, follow these steps:

1. Inspect the PLC door to locate the original factory settings.
2. Ensure that the PLC battery backup is functioning correctly to prevent future occurrences. Make sure it has good contact and is properly installed.
3. Certain factory settings may need to be restored. Confirm or enter weight factor, C1 and C2, Xtimer, Bline, Batch unit, Autotune, Autotune gain correct.
 - a. Refer to section 6.3 above (UPLOADING PROGRAM WHEN Cal C1 and Cal C2, and Other System Values are Known) 8-16

7.9 No Signal from Flow Sensor(s)

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

1. Verify that the cable and connections are in good condition and securely connected on each end of the yellow Turck cable.
2. Ensure that the pins on the 6-pin connectors are not damaged or bent.
3. Contact your CADARO representative for further assistance.

7.10 NAN (Not a Number) Value

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

1. Record the C1 and C2 values along with their respective flow rates.



2. Navigate to the FIELD CAL, CH#1 <HIGH FLOWRATE> screen and record the 4 decimal place number under the “WT-CAL-01” heading. This is the C1 factor. ALSO, record the flow rate.
3. Navigate to the FIELD CAL, CH#1 <LOW FLOWRATE> screen and record the 4 decimal place number under the “WT-CAL-02” heading. This is the C2 factor. ALSO, record the flow rate.

8 Service and Repair

8.1 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

8.2 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.

9 Specifications

9.1 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 1/8" x 13" x 11 5/8"	67 -
INTEGRAL NS/5K INTEGRAL NSL/5K	1,750	5,000	9 3/4" x 9 3/4" ID	Square	30 3/8" x 16 1/4" x 15"	135 200
INTEGRAL NS/20K INTEGRAL NSL/20K	5,000	20,000	17 3/4" x 17 3/4" ID	Square	36 1/2" x 23 5/8" x 24 3/4"	210 275
INTEGRAL NS/50K INTEGRAL NSL/50K	17,500	50,000	29 3/4" x 29 3/4" ID	Square	36 1/2" x 37" x 35 5/8"	375 425

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

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



9.3 PLC Control box: 12.8 lbs. for single channel

9.4 Power rating: 1.3 amps at 110VAC

9.5 Rated capacity

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

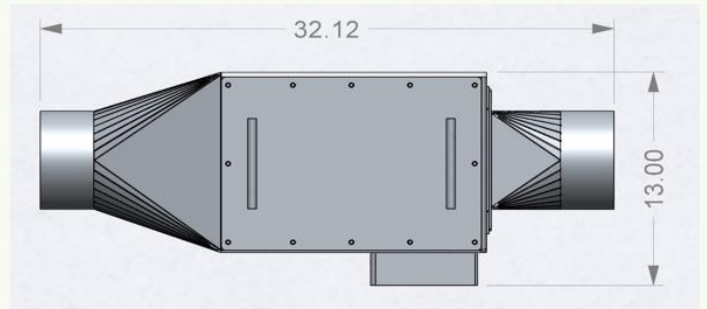
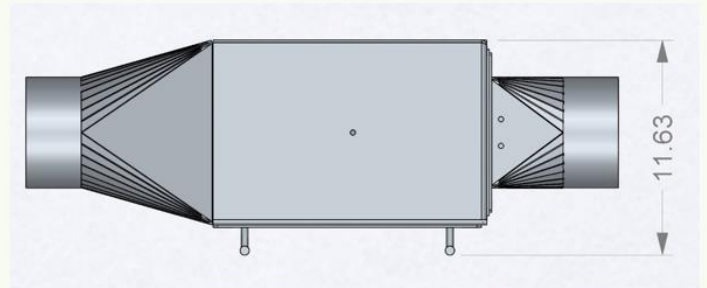
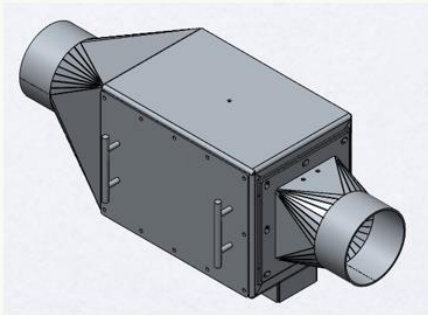
Flow Sensor

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

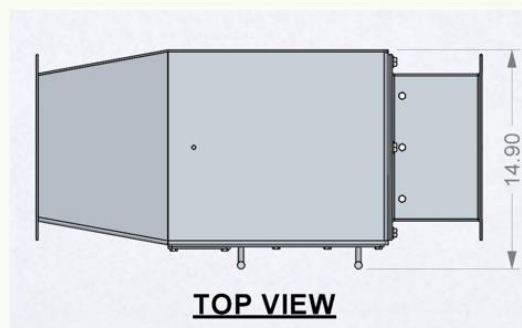
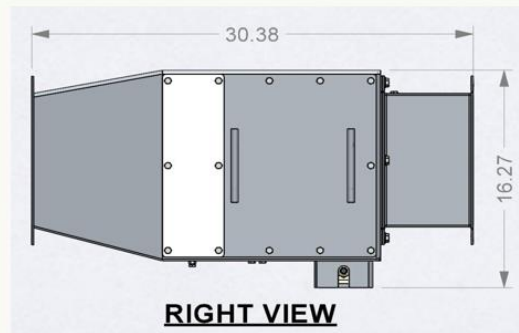
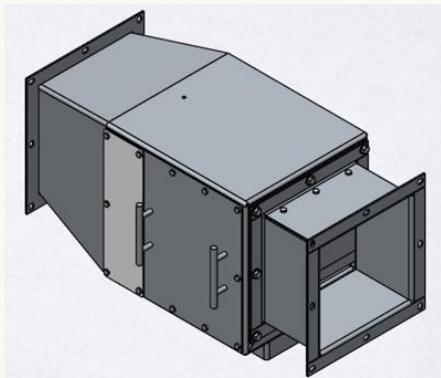
The PLC Control box requires a 110VAC and Un-interruptible Power Supply (UPS) [recommended] along with spike free, steady voltage. Electrical components may not be covered under OEM warranty if a quality UPS is not used to power the system. It is further recommended that a professional licensed electrician (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.

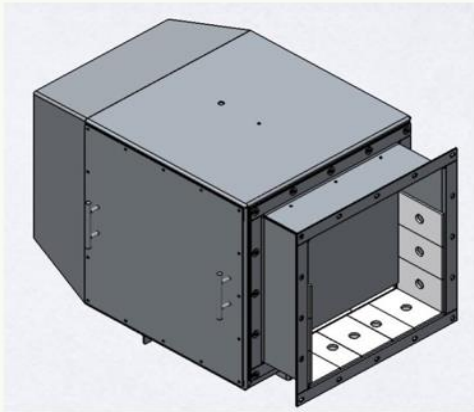
9.6Flow Sensor Dimensions: Integral Models

Integral NR/2K

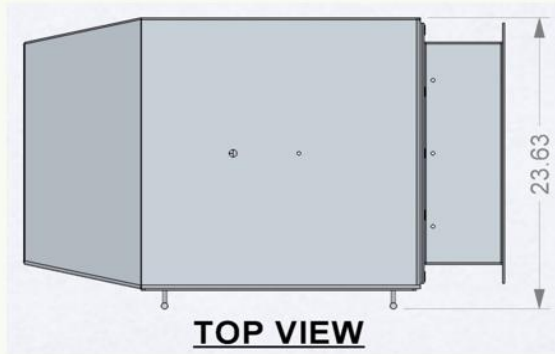
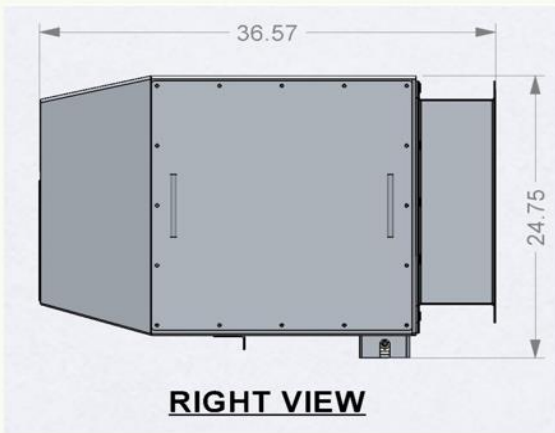


Integral NS/5K

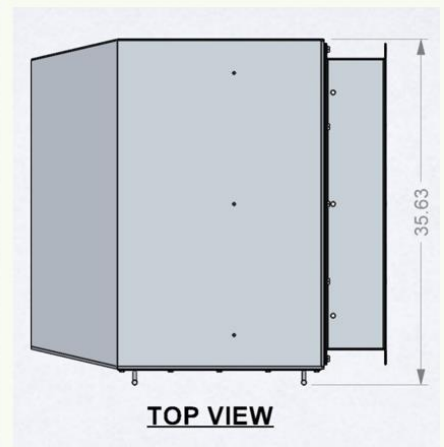
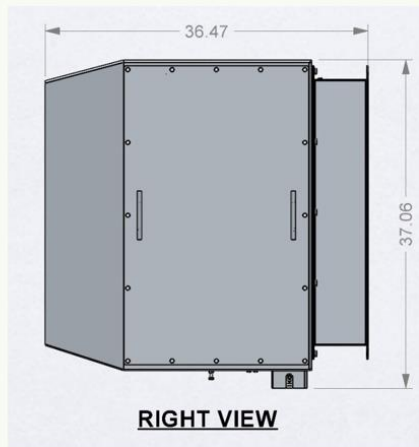
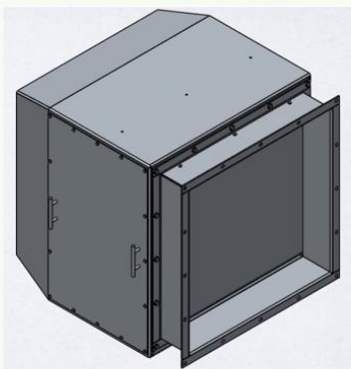




Integral NS/20K



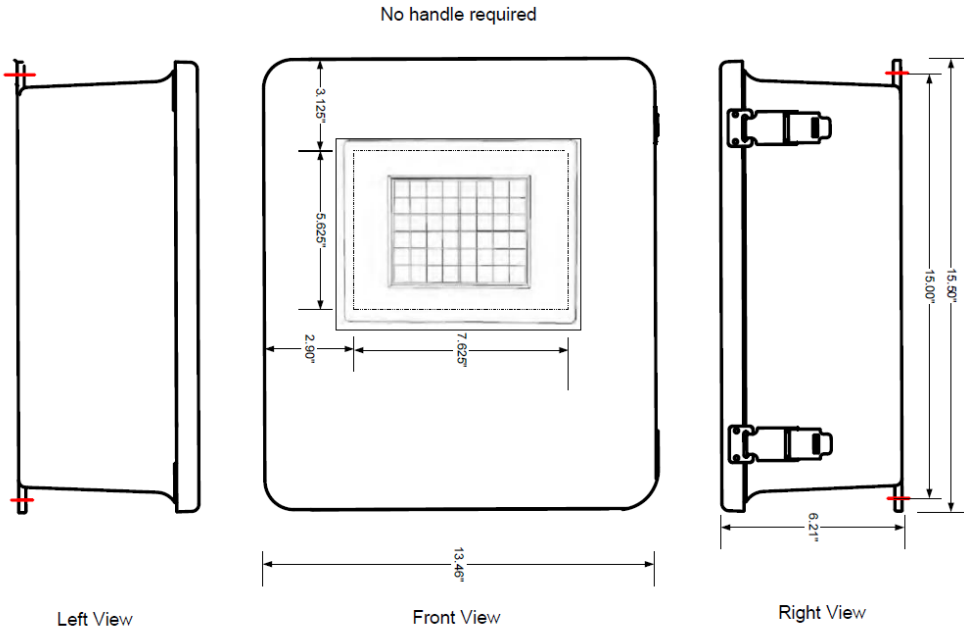
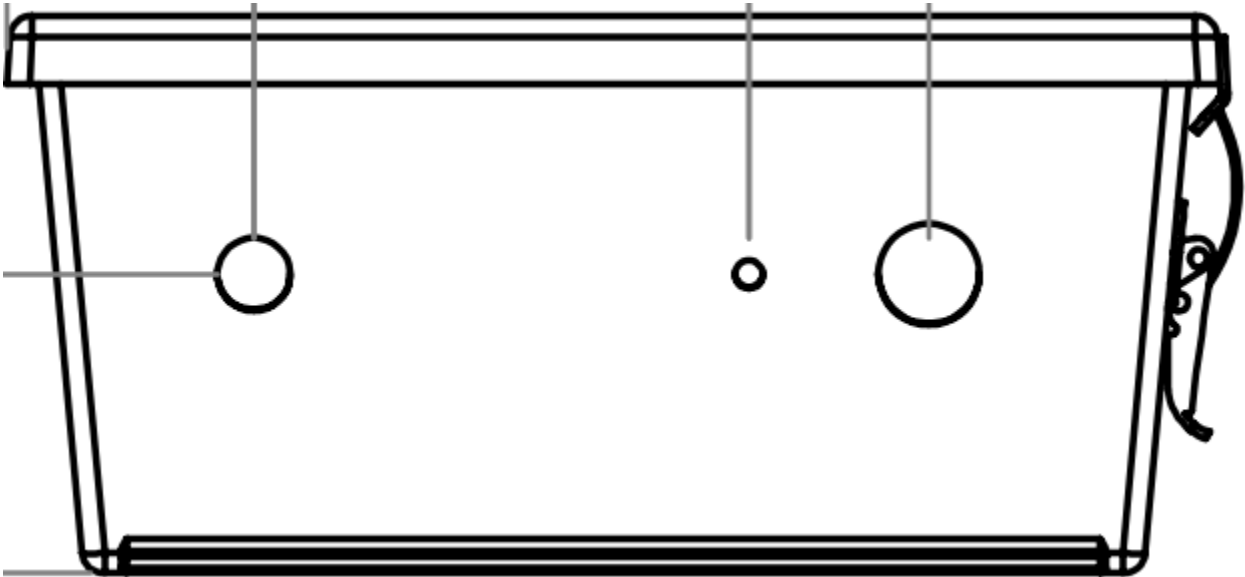
Integral NS/50K



9.7 PLC control box Dimensions:

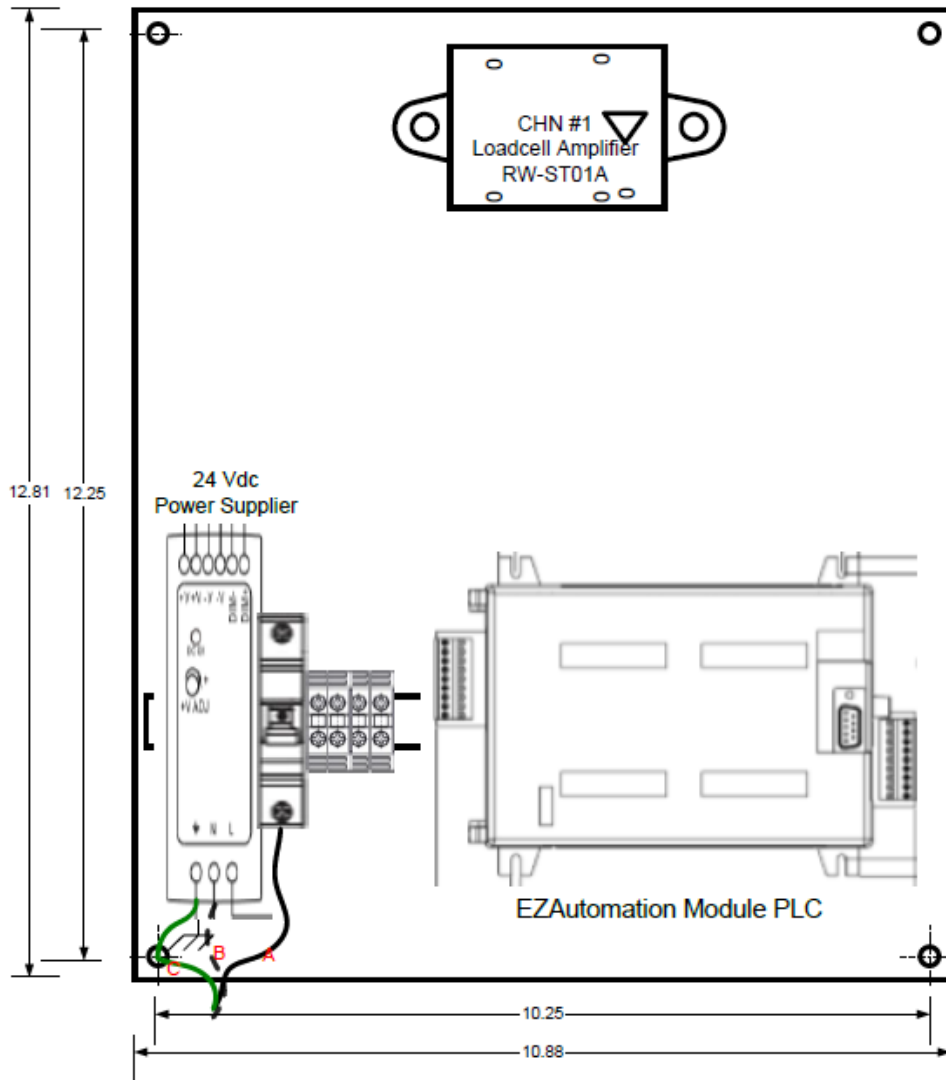
Figure 4. PLC control box Enclosure with 6-inch HMI

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.

9.8 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



10 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.

THESE WARRANTIES EXCLUDE ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. NEITHER CADARO NOR DISTRIBUTOR WILL, IN ANY EVENT, BE LIABLE FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

CADARO AND BUYER AGREE THAT CADARO’ SOLE AND EXCLUSIVE LIABILITY HEREUNDER IS LIMITED TO REPAIR OR REPLACEMENT OF SUCH GOODS. IN ACCEPTING THIS WARRANTY, THE BUYER WAIVES ANY AND ALL OTHER CLAIMS TO WARRANTY.

SHOULD THE SELLER BE OTHER THAN CADARO, THE BUYER AGREES TO LOOK ONLY TO THE SELLER FOR WARRANTY CLAIM.

NO TERMS, CONDITIONS, UNDERSTANDING, OR AGREEMENTS PURPORTING TO MODIFY THE TERMS OF THIS WARRANTY SHALL HAVE ANY LEGAL EFFECT UNLESS MADE IN WRITING AND SIGNED BY A CORPORATE OFFICER OF CADARO AND THE BUYER.

U.S. Pat. 6,805,014 and 6,973,843 – Other Patents Pending.

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Recommended Information to be stored in PLC Control Box



Date _____
 Serial Number Flow Sensor _____
 Serial Number PLC Control Box _____
 Load Cell Tare _____
 Standard Weight _____
 Xtimer _____
 Software Version _____

IP Address _____
 Subnet _____
 Gateway _____

Calibration

Date	Product	Flowrate (lbs/min) Cal 1	Cal C1 Value	Flowrate Cal 2	Cal C2 Value
	Example: Corn	2500	1.5123	2200	1.2123

service@CADARO.com

806-338-7478