N5 Sensors

ChemNode Installation Manual

Scope

The manual covers the basic methods of installation and operation of the ChemNode sensors used in N5SHIELD™. N5Shield™ is an end-to-end solution that leverages cloud-connected smarter sensors (ChemNodes), artificial intelligence, an intuitive dashboard, and real time alerts. The purpose of N5SHIELD is to provide real time alerts for detection of nearby wildfire and air quality to emergency responders to air in wildland firefighting and resource utilization.

Each N5SHIELD™ System consists of an array of ground-based sensor nodes (ChemNodes) and gateways, deployed according to a local analysis of terrain and risk factors. For questions about system selection and purchasing, please contact N5 Sensors at info@n5sensors.com.

For instructions on how to access and use the dashboard, please consult document "N5SHIELD_DashboardAccess"

Videos of the components and the installation process can be viewed at

https://www.youtube.com/playlist?list=PLewf5RJdGD_9kYZ781qORtQpVqk5FcRvq

Hardware Description and Specifications

ChemNode Sensor Nodes

Each individual sensor node includes multiple sensors plus LTE or LoRa radio for data transmission. At the heart of each ChemNode is a patented Semiconductor-Photocatalytic Hybrid Sensor array designed to detect chemicals associated with fire and environmental air quality. Additional sensors include a high sensitivity laser particle sensor, infrared array heat sensor, temperature, humidity, and pressure sensor. This unique sensor suite provides deep insight into hyperlocal conditions which is useful for wildfire detection, prediction of fire behavior, and providing additional information on localized air quality and potential health impacts.

ChemNode Functional Specifications

Function	Stationary, outdoor detection of conditions indicating the likely presence of nearby fire when sensors are deployed consistent with recommended geographic deployment plan.
Weight	Approximately 4 pounds
Dimensions	Approximately 12” x 9” x 6”
Weather Resistance	IP64
Operating Temperature Range	TBD
Storage Temperature Range	TBD
Recommended Storage Time	60 days. The ChemNodes are shipped in a low power mode, with sufficient battery charge to run for 60 days in storage and then start immediately on deployment. Longer storage will not harm the ChemNode, but will require at least 4 hours of recharging in good sunlight before the device will connect to the network.
Recommended Warm Up Time	1 week. Sensors will begin providing data as soon as they are connected and charged, but fire notification alerts will be less accurate in the first week and must be independently verified

Sensor Parameters

Particle Sensor Type	Laser Particulate Matter Sensor SPS30
Mass Concentration Size Range	1.0, 2.5, 4.0, 10 µm
Mass Concentration Range	0 to 1000 µg/m3
Heat Sensor Type	Infrared Array Sensor AMG88
Heat Sensor Dimensional Area	8 x 8 (64 pixels)
Heat Sensor Range	-4°F to +212°F
Heat Sensor Viewing Angle	60°
Gas Sensor Type	Custom Semiconductor Photocatalytic Hybrid Array

Power

Battery	30,000 mAh
Solar Charger	20W
Dimensions (Solar Panel)	Approximately 14” x 18” x 3”
Weight (Solar Panel)	Approximately 4.5 pounds

Communication

LoRa	168dB maximum link budget +20dBm - 100mW constant RF output vs. Vsupply +14dBm high efficiency PA
LTE	Multimode LTE-M/NB-IoT modem with integrated RFFE Certified LTE bands: B1, B2, B3, B4, B5, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28 and B66 Multi carrier data service works on AT&T, T-Mobile and Verizon

Product Specifications are subject to change and may be confirmed at time of shipment if different from quote or purchase order.

Gateway

Where appropriate, N5 sensor nodes are equipped with high efficiency, multi-carrier SIM cards to communicate directly with the cloud. In some installations, it is either necessary or preferable to connect individual sensor nodes to a Gateway via LoRa radio. In this case, multiple individual sensor nodes can be deployed without concern for LTE connection, and the Gateway can be situated at a convenient location. The analysis of LTE coverage and recommendation for use of Gateways and LoRa is covered during the preliminary site review

Gateway Functional Specifications

Function	Used for deployments where LTE coverage is limited. Gateway connects to cloud via LTE and to surrounding nodes via LoRa
Weight (Gateway)	Approximately 4 pounds
Dimensions (ChemNode)	Approximately 12” x 9” x 4”
Weather Resistance	IP64
Operating Temperature Range	TBD
Storage Temperature Range	TBD
Recommended Storage Time	60 days. The Gateways are shipped in a low power mode, with sufficient battery charge to run for 60 days in storage and then start immediately on deployment. Longer storage will not harm the ChemNode, but will require at least 4 hours of recharging in good sunlight before the device will connect to the network
Recommended Warm Up Time	15 minutes

Gateway Power Specifications

Battery	30,000 mAh
Solar Charger	20W
Dimensions (Solar Panel)	Approximately 14” x 18” x 3”
Weight (Solar Panel)	Approximately 4.5 pounds

Gateway Communication Specifications

LoRa	168dB maximum link budget +20dBm - 100mW constant RF output vs. V supply +14dBm high efficiency PA
LTE	Multimode LTE-M/NB-IoT modem with integrated RFFE Certified LTE bands: B1, B2, B3, B4, B5, B8, B12, B13, B14, B17, B18, B19, B20, B25, B26, B28 and B66 Multi carrier data service works on AT&T, T-Mobile and Verizon

Equipment Included with Shipment

Each N5SHIELD system is shipped with the following equipment and materials

1. A master list of all hardware included in the shipment.
2. Individual ChemNode(s), each packed in its own box
3. Individual Gateway(s), each packed in its own box
4. Solar panel and mounting kit are packaged two per box. One solar panel and mounting kit is provided for each ChemNode and Gateway.
5. T27 security bit, used to affix ChemNode to bracket

ChemNode Sensor Nodes

Each ChemNode is shipped in its own box. The ChemNode is shipped in a low power state and will immediately power up when the solar panel is connected. ChemNodes are shipped partially charged, to allow immediate startup and verification of ID and LTE connectivity. N5 recommends installing the ChemNode within 60 days of receipt. Longer storage will not harm the ChemNode but will result in the device needing to be charged overnight prior to validation of ID and connectivity.

Each ChemNode is shipped with either a LoRa or LTE radio installed. The configuration and ID are shown on a sticker affixed at the bottom of the ChemNode (Figure 1). The same ID number is also shown on the outside of the individual ChemNode box. Customer should record ID number to pair with GPS coordinate of sensor during installation.

Figure 1: ChemNode Label, ID, and location. IMPORTANT: Customer is responsible for recording GPS locations for each ChemNode

Gateway

Each Gateway is shipped in its own box. Gateways are shipped partially charged, to allow immediate startup and verification of connectivity. N5 recommends installing the Gateway within 60 days of receipt. Longer storage will not harm the Gateway. It is important to connect the battery prior to installation of the gateway. Figures 3 and 4 demonstrate how to connect the battery inside the gateway enclosure. After connecting and closing, the gateway is ready to be installed.

Figure 2: Connecting Gateway battery before installation

Solar Panel Assembly

Figure 3: Solar Panel Assembly with components labeled

The solar panel assembly is shown assembled in Figure 3. Figure 4 shows how the flat packed solar assembly will look upon unboxing. The solar panel assembly box includes the following components.

1. Mounting Pole, 2 foot in length, secure to sensor mounting location, before inserting the solar panel assembly into the coupler.
2. Solar Panel Assembly, referred to as Solar Pole, which includes pole, solar panel, and bracket, ChemNode bracket, power cable and LoRa / LTE cable and antenna.

Figure 4: Solar Panel Assembly as packaged with top view, bottom view, and the solar and mounting poles

Site Preparation and Requirements

ChemNode locations are pre-defined based on a site survey and analysis of terrain, LTE, wind, accessibility, and key infrastructure. The site survey will include approximate GPS locations for installation. Each installation location should include existing infrastructure (telephone pole, street / highway signals or signage, fence posts, etc.) or installation of a supporting post will be required.

If the ChemNode is mounted in a fixed, standalone location, the general recommendation is to use a ten-foot, 1.5-inch diameter steel pole 6 feet above ground height, with a minimum of 3 feet below ground buried into the earth. Local building codes and permits should always be consulted before proceeding with installation of mounting poles. Frost lines for your region should also be considered. Long term installations should have mounting poles installed at a depth surpassing the frost line for your region by approximately 6-12 inches.

If mounting to an existing structure and using the included mounting bracket, please ensure that the connection to existing structure is securely bolted or fastened. If mounting to existing infrastructure, the ChemNode bracket can be used separately from the mounting pole to secure the ChemNode directly to the structure. For non-standard installations, please contact N5 at CustomerService@N5Sensors.com for guidance and recommendations.

Solar Panel and ChemNode Orientation

The solar panel should be mounted facing true (not magnetic) south and should be free of obstruction that would prevent sunlight from reaching the solar panel. The solar panel should be mounted at an angle of 23 to 25 degrees from horizontal for the best charging performance in a fixed installation. As you move

from the equator, solar efficiency might benefit from twice yearly solar panel angle adjustments during summer and winter if the solar panel is installed in a location with limited sunlight availability (e.g. below tree covers).

The optimal tilt from level depends on geographical location and the season. The optimum tilt angle is calculated by adding 15 degrees to your latitude during winter and subtracting 15 degrees from your latitude during summer. If your latitude is 34°, the optimum tilt angle for your solar panels during winter will be 34 + 15 = 49°. The summer optimum tilt angle on the other hand will be 34 – 15 = 19°. Typically, N5 recommends a fixed installation at 23 to 25 degrees from level. When performing a site survey, N5 will provide recommendations for periodic solar panel adjustment if required. For best charging efficiency, the solar panel should receive at least 4 hours of direct sun per day.

The magnetic declination of your region is the degree to which the magnetic south shown on your compass differs from the true south which your solar panels should face. True south can vary depending on geographical location. Using the link below, you can find the magnetic declination of your region using the coordinate information of the sensor. Panels should face true south, as indicated by the magnetic declination angle.

https://www.ngdc.noaa.gov/geomag/calculators/magcalc.shtml

The ChemNode includes an IR heat sensor with a field of view of 60 degrees. The ChemNode should be mounted so that the IR heat sensor is facing the area of highest fire risk and / or most interest.

The ChemNode should preferably be mounted at a height of 8 to 15 feet. If the infrastructure makes it preferable to mount outside of the target range, please consult N5 at customerservice@n5sensors.com before proceeding.

Installation

The ChemNode systems are designed for rapid and easy deployment and are shipped partially assembled. ChemNode installation consists of these basic steps.

1. Unpack the boxes and lay out the hardware

2. Affix the 2-foot mounting pole to a suitable post, wall, tripod, or other existing infrastructure. This pole will have no chemnode bracket or antenna attached. Depending on installation location, use of the mounting pole may not be necessary. Two large hose clamps are suitable for mounting to most posts, or poles, but the figure below depicts other mounting options. Contact CustomerService@N5Sensors.com for suitable mounting hardware if needed.

Figure 5: Mounting Pole and different potential mounting options for multiple surface types

3. With the mounting pole affixed, return to the solar panel and hose clamp it to the solar pole, using the hose clamps already attached to the bracket. Slide the pole into the hose clamps and align the pole with the label just below the hose clamp. Tighten using flat head screwdriver or 5/16" driver. ChemNode bracket should be at the upper half of the pole, with the solar panel mounted at the lowest point.

Figure 6: Solar Pole and Solar Panel as received. Note the hose clamps on the solar panel bracket

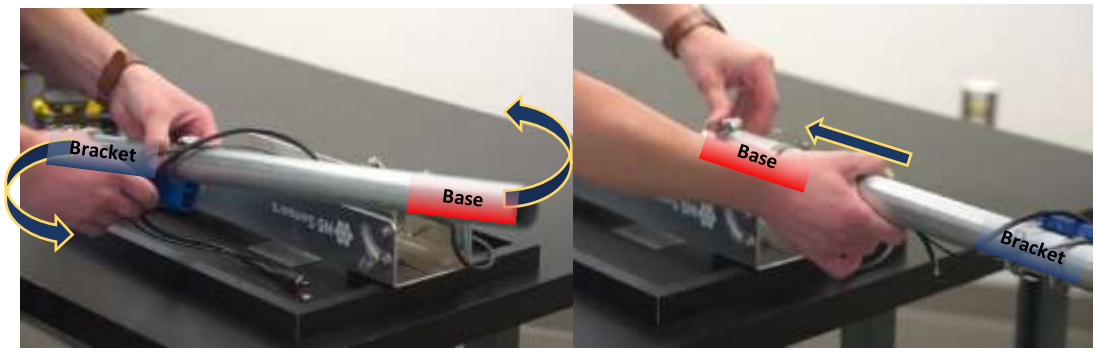


Figure 7: Rotate Pole 180 degrees as shown and insert. Note the change in ChemNode bracket/base orientation

Figure 8: Solar pole connected to solar panel bracket

4. Loosen 10 mm bolts on left- and right-hand sides of bracket to free bracket angle adjustment. Tilt panel to desired angle. Refer to solar panel and chemnode orientation section above to find the correct angle for your location. Retighten bolts once set to the correct angle.

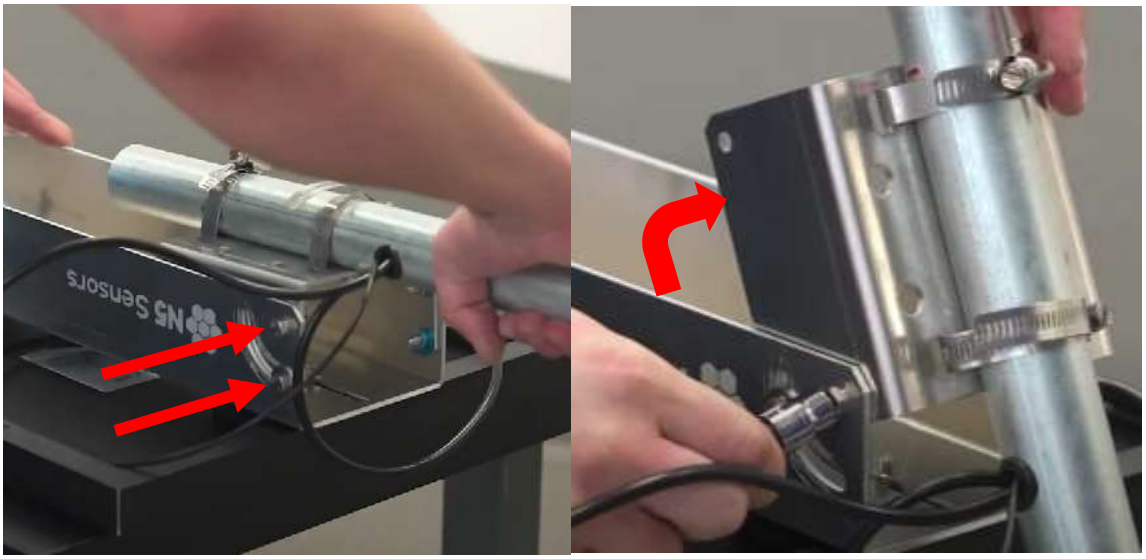


Figure 9: With the panel facedown at the edge of a surface, loosen, tilt, and retighten the solar panel pole at the correct angle

5. Install the Solar Panel Assembly to the mounting pole. Press the pole down into coupler and tighten coupler until secure. Ensure the solar panel is aligned to face south if deploying in the Northern Hemisphere. Consult the solar panel and chemnode orientation section above for correct angle.

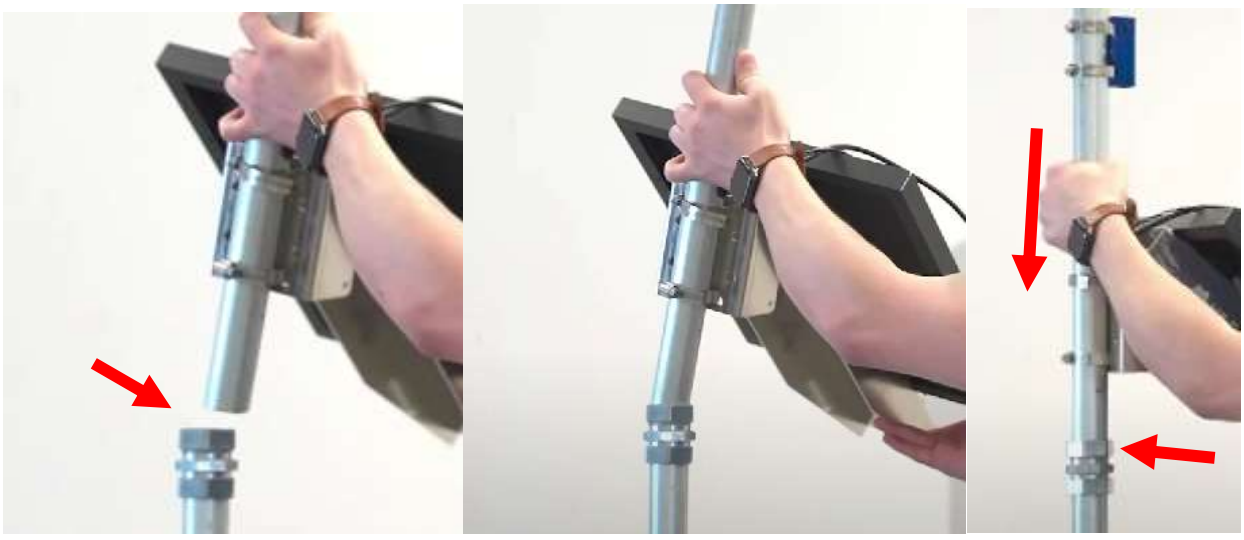


Figure 10: Connect Solar Pole to Mounting Pole, press down, and tighten coupler until secure

6. Ensure that the blue ChemNode mounting bracket on the pole is facing the area(s) of highest interest and retighten hose clamps if required. ChemNode bracket should be at the upper half of the pole, with the solar panel mounted at the lowest point. Next, attach the ChemNode to the blue mounting bracket by aligning the back of the ChemNode with the larger holes in the bracket, and then slide down to secure the ChemNode on the bracket and allow for the insertion of the security screw.

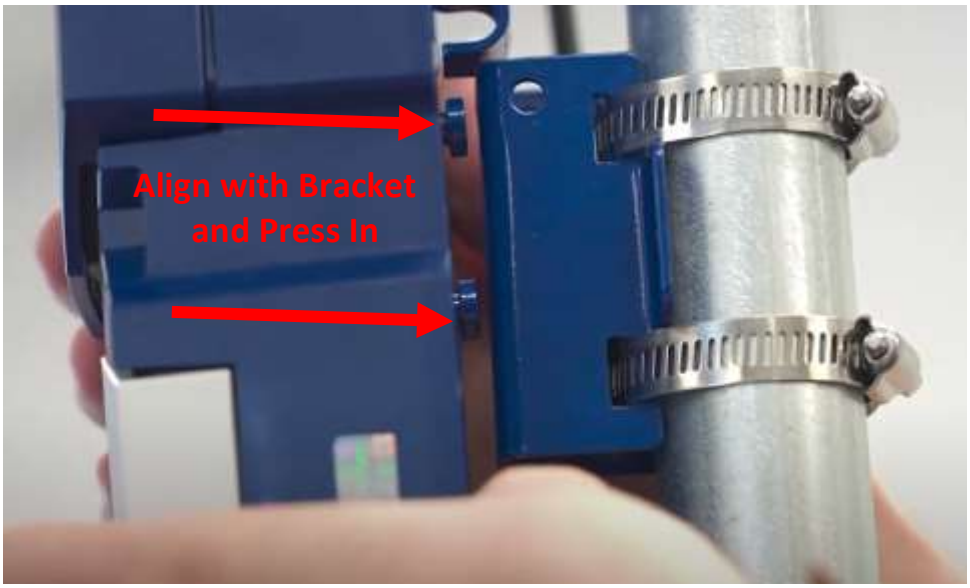


Figure 2: Align mounting pegs with bracket and press ChemNode onto pole

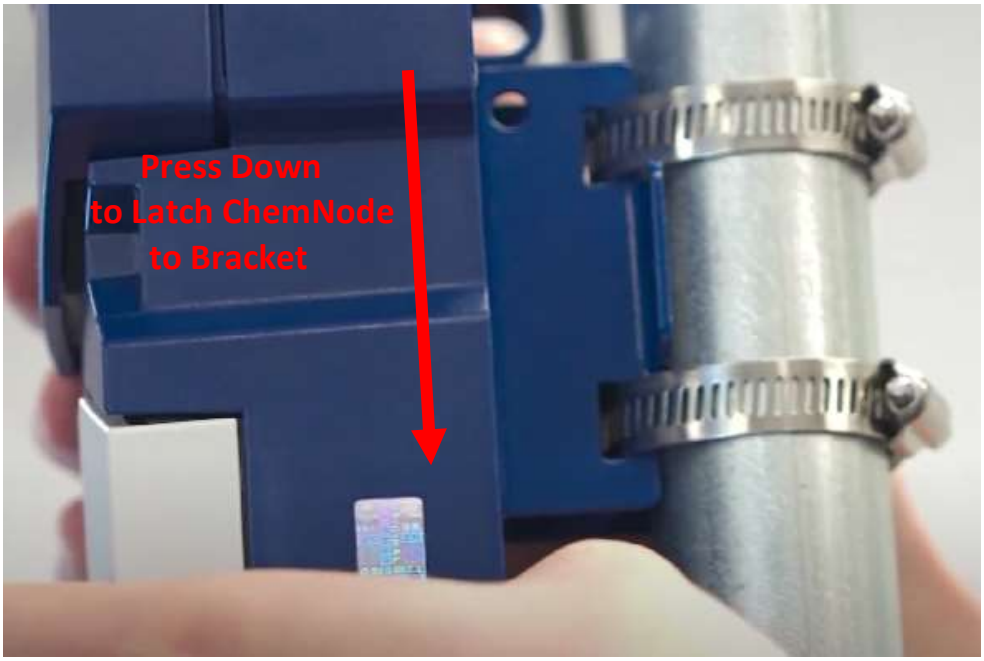


Figure 12: Press downward to latch ChemNode onto the bracket

7. Insert the security screw into the ChemNode Bracket. With the included T27 security bit, tighten the security screw by hand until secure. This is a tamperproof screw, to prevent unauthorized ChemNode removal.

Figure 13: Installation of security screw

8. Determine which type of ChemNode is being installed, either LTE or LoRa version will be shipped.

Figure 3: Power and Antenna connectors for LTE (Left) and LoRa (Right)

9. Connect power cable as shown below and tighten threaded ring around connector. Ensure that cable is pressed all the way into connector, and the threaded ring is finger tightened until secure.

Figure 15: Insert and tighten threaded power connector onto ChemNode (LTE ChemNode Shown)

10. Connect antenna cable to open connector at top of ChemNode and tighten threaded ring. View the graphic below to ensure that the correct antenna connection is made. LTE antenna will be closest to power connector while the LoRa antenna will be further away. Ensure that cable is pressed all the way into connector, and the threaded ring is finger tightened until secure.

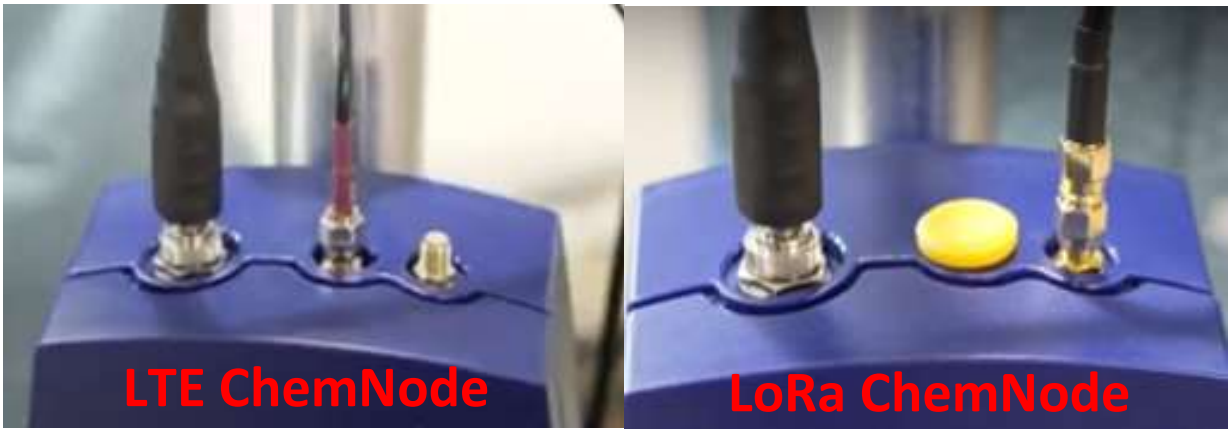


Figure 16: Insert and tighten threaded antenna connector onto ChemNode

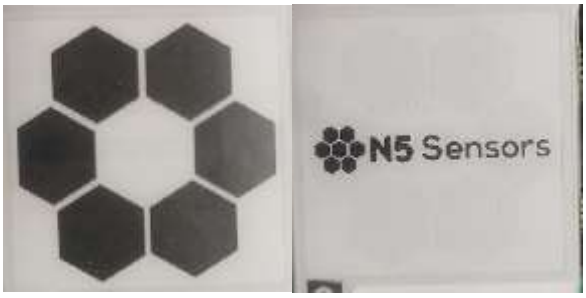
Once the cable connections are made, the chemnode and solar panel assembly setup is complete.

Operation

Once the solar panel is connected, the ChemNode will automatically start a power up sequence. The e-paper screen will show the status.

Normally, the ChemNode is shipped with enough charge on the battery to allow it to turn on and operate, even if installed late in the day. If the ChemNode has been stored for an unusually long period of time, the display may show the low power mode screen. When the solar panel is receiving sufficient sun to charge the ChemNode, the display will indicate “charging”. When there is not enough light for charging, the ChemNode will display “discharging”.

The user is responsible for communicating the location of the ChemNode to N5 for display on the dashboard. When the Unit is first installed, please record the Device ID (visible on the e-paper screen and on a sticker on the bottom of the ChemNode) and the GPS coordinates. This information should be relayed to your N5 representative assisting with your installation.

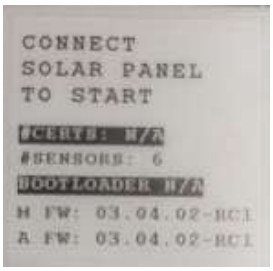
	When the ChemNode is received it will be in a low power “ready” state. When the solar panel is connected, the ChemNode will automatically start a power up sequence.
	The N5 logo will display while the system is starting up. When the System becomes operational, the display will change to “N5 Sensors.
	LTE and LoRa ChemNode in operation. The “Cloud Online” will slowly blink on and off. The display will indicate if the ChemNode is currently in the process of charging or discharging

	When the sensor is not connected to the internet, the display will display cloud offline. Normally the connection will restore itself with no action from the user.
	Low power mode – When the system does not have sufficient power for operation, the display will show a “Low Power Mode”.
	Low power mode – When the system does not have sufficient power for operation, the display will show a “Low Power Mode”.

Troubleshooting

For questions or if additional support is needed, please contact N5 at customerservice@n5sensors.com.

If the ChemNodes are to be moved / repositioned, it is recommended to put the units into low power mode. The method for doing this is to remove and replace the solar cable from the connector 2 times, quickly. The ChemNode will return to the ready screen as shown:



The N5SHIELD components (gateway and ChemNode) contain Lithium batteries and should not be disposed of in the regular waste stream. Please return to N5 when / if disposition is required.