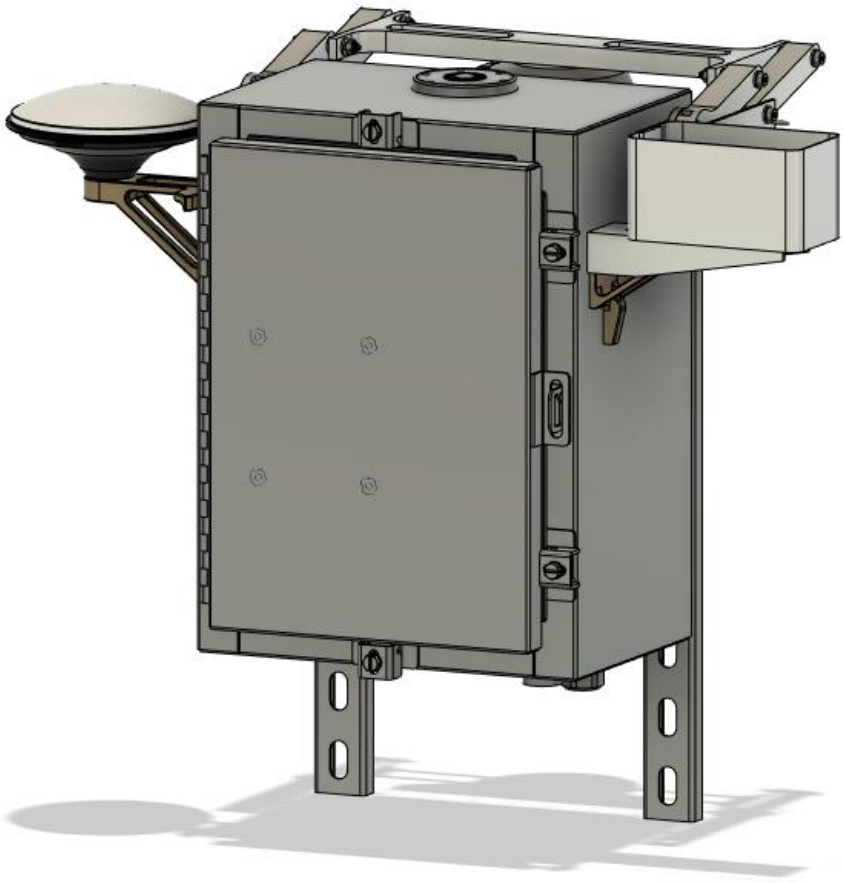
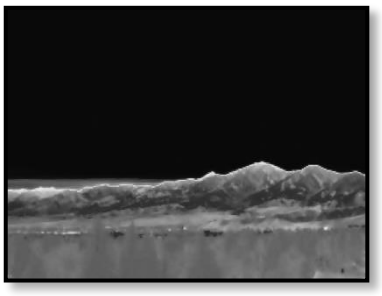
All-Sky Infrared Cloud Imager (ICI)

Installation Manual



NWB Sensors, Inc.

Contact Information



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Instrument Overview

The All-Sky Infrared Cloud Imager (ICI) detects and classifies clouds using a calibrated long-wave infrared (LWIR) thermal imaging camera. The system operates by observing the LWIR emission of the sky and clouds and then removing the emission of the sky to produce a residual radiance from which measured cloud products are derived.

The instrument is separated into two enclosures which are connected by cables. The Camera Enclosure mounts outdoors, and the Power Enclosure mounts inside a climate-controlled building. The exterior Camera Enclosure is a climate-controlled aluminum box that houses the camera and supporting electronics. The Camera Enclosure has a hatch that closes during rain or high winds to protect the camera lens. The Power Enclosure houses the power supplies and control circuitry.

Scope

This guide documents the installation site requirements, the required tools and hardware needed for installation, and the steps required to install the system.

Supporting Documents

This document is one of several which describe the installation, maintenance, and operation of the ICI. As appropriate, refer to the related documents provided with the instrument:

- *All-Sky Infrared Cloud Imager Installation Manual*
- *All-Sky Infrared Cloud Imager Hardware Maintenance Manual*
- *All-Sky Infrared Cloud Imager Software Operations Manual*
- *All-Sky Infrared Cloud Imager Camera & Lens Swap Manual (optional)*

Figure 1.Front of ICI mounting with weather sensor option (left) rear of ICI Camera Enclosure (middle) Power Enclosure (right)

Site Requirements

Camera Enclosure Placement

The ICI is capable of monitoring clouds over the entire sky (180° field of view hemisphere). To create the best benefit to the customer, the Camera Enclosure should be installed outdoors to maximize its unobstructed field of view. Typically, this entails rigidly mounting the camera enclosure on top of a building or on an elevated platform to reduce obstruction by nearby trees and buildings. All stationary ground objects are masked out of the cloud products generated by the ICI. As a rule, neighboring objects should not reach more than 20° above the horizon as viewed from the ICI. We prefer those neighboring objects be restricted to 10° above the horizon. A limited number of stationary towers, lighting rods, or power poles which reach above this level are not considered problematic if their horizontal cross section is less than 2° as viewed from the ICI. Moving objects cannot be masked by the ICI software. They may be falsely identified as clouds. For this reason, moving objects should remain below the Camera Enclosure but can also reside in front of a ground object that is masked, such as a building or mountain, without causing issue. If concerns arise, contact NWB Sensors for consultation.

Rigid structure (typically Unistrut) must be provided to support the 35-lb Camera Enclosure. See *Mounting the Camera Enclosure* below. Ideally, installations in the northern hemisphere should orient the structure with the fans to the North. Similarly, southern hemisphere installations should orient the structure with the fans to the South. See Figure 2.

In addition to the Camera Enclosure, an (optional) weather sensor is typically included with the system. The weather sensor connects to the bottom of the Camera Enclosure so the maximum separation distance between the two is limited by the sensor's 5 m (16 ft) cable length.

The maximum distance between the Camera and Power Enclosures is dictated by the standard three 50 ft cables connecting the enclosures: a data cable (fiber), a TEC power cable, and a power cable. Custom cable lengths are available up to 30 m (96 ft).

Power Enclosure Placement

The Power Enclosure must be installed in a powered (120 VAC), indoor, and climate-controlled environment. The building environment must be maintained between 0-35 C, noncondensing, moisture-free, and free of excessive dust. It must be located within 8 feet of a standard 120V power outlet. The 25-lb Power Enclosure must be properly supported and cannot be mounted to drywall. See *Mounting the Power Enclosure* below.

Local Area Network Requirements

Although the ICI can operate as a standalone instrument which logs imagery, the typical setup is for an external server to download data products from the ICI in real time. When connected to a local area network, the ICI provides for remote access to real-time data products and support for limited remote commanding. The local network at the installation site must provide the following:

1. Ethernet (10/100 or Gigabit), or LC multi-mode fiber (850-nm). The fiber connection uses a Blackbox LFP411 module. See its datasheet for fiber compatibility requirements.
2. DHCP IP assignment. The ICI obtains its IP over DHCP. Maintaining a DHCP reservation in the router table is recommended. A host name is assigned which can be resolved over multicast DNS (mDNS) as well and is provided upon delivery. As desired, NWB Sensors can assign a custom static IP address of your choice prior to shipment. Contact NWB for more information.
3. Network Time Protocol (NTP) server access. When used on a network with internet access, the ICI will synchronize with pool.ntp.org servers by default. For installations without an internet connection a local NTP server must be deployed. See the *Software Operations Manual* for instructions on setting the NTP server address in the ICI embedded computer.
4. Both remote commanding and data access require SSH/SFTP protocols. As necessary, firewalls must allow SSH/SFTP traffic on port 22.
5. (Optional) A basic web page including current images from the instrument are served over standard HTTP on port 80. Additional telemetry can be access from the internal Grafana server on port 3000. As desired, HTTP access can be permanently disabled for enhanced security. Otherwise, firewalls must allow HTTP traffic on ports 80 and 3000.

Surface Meteorology Data Requirements

The ICI software requires real-time observations of the local atmosphere to properly account for the sky radiance emitted below clouds. In addition, wind speed is used to determine when blowing debris may be a threat to the system. Under high winds, the system autonomously closes its hatch.

With the standard system, local surface meteorology is provided by an integrated Weather Sensor. This provides an all-in-one solution for the requisite meteorology. Alternatively, surface meteorology data (temperature, humidity, barometric pressure, and wind speed) can be posted to the system using the application interface. This allows the customer the capability to use an external source for surface meteorology observations.

Location Requirements and Precipitable Water Vapor Retrieval

The ICI software uses time, its geodetic location, and the detected position of the sun across frames to determine its precise alignment to the sky. With the standard system, a GNSS antenna and receiver system are included to allow the system to autonomously determine its location and alignment. Furthermore, the ICI can

use its GNSS system to derive in-situ measurements of the precipitable water vapor (PWV) which improve the atmospheric characterization over what is available through surface meteorology only. The PWV retrieval requires that the ICI access real time precise ephemeris and clock information from the internet. An internet-enabled network connection is required to enable this capability.

To accommodate site security requirements, the customer can elect to remove the GNSS system from the instrument. In this case, the system location must be set manually in the configuration file and the GNSS-derived PWV will be unavailable. In this case, external PWV observations must be posted to the instrument using the software application interface to allow for proper ICI operation.

Installation

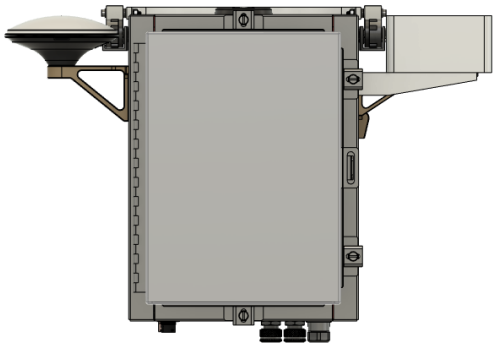
Preparation

To install the ICI instrument, first ensure that all ICI components (listed in the next section) have been received. Then, determine the mounting hardware needed. This hardware is dependent on the specific setup. A recommended setup is described below.

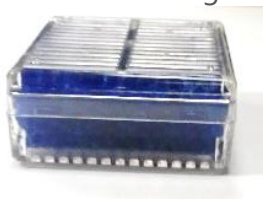
ICI Components

The ICI is shipped in two boxes; for each item, the component shipping box is denoted.

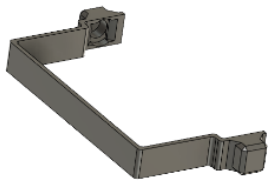
1. Camera Enclosure (16" x 12" x 8" Aluminum) with hatch, rain sensor, and (optional) GPS antenna. Eight (8) boxes of desiccant (45.5-gram blue silica gel reusable DriBox) installed in the enclosure (Box 1 of 2)



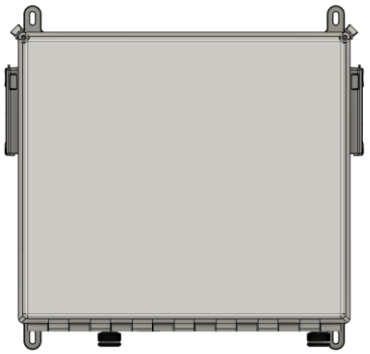
2. Desiccant: 45.5-gram blue silica gel reusable DriBox ships in foil bags (Qty: 2 packs of 4) (Box 2 of 2)



3. Desiccant/DriBox retaining clips, small gray plastic installed in the instrument (Qty: 12) (Box 2 of 2)



4. Power Enclosure (12" x 14" x 8" Fiberglass) (Box 2 of 2)



5. Power Enclosure mounting feet (Qty: 4) (Box 2 of 2)
   (Mounting feet may already be mounted to the Power Enclosure at time of shipment.)

6. Hatch lock hair pins (McMaster-Carr 90026A104) (Qty: 2) (Box 2 of 2)
7. Data cable (fiber) with watertight connectors (50 feet or custom length) (Box 2 of 2)
8. TEC power cable with 7-pin watertight bayonet connectors (50 feet or custom length) (Box 2 of 2)
9. Power cable with 12-pin watertight bayonet connectors (50 feet or custom length) (Box 2 of 2)
10. (Optional) Weather Sensor
    a. MET One AIO 2 Sonic weather sensor (Box 2 of 2)

    b. Weather sensor ¾" IPS pipe vertical mounting adaptor (Qty: 1) (Box 2 of 2)
    c. Weather sensor cable with 12-pin watertight clicklock and 10-pin watertight bayonet connectors (15 feet) (Box 2 of 2)
11. (Optional) a backup camera is shipped in a black protective case (Box 1 of 2). The recipient must store this camera in a climate-controlled storage area.

Mounting Hardware for Recommended Setup (not included)

The following recommended mounting hardware must be provided by the customer and will vary depending on the specifics of the installation site.

1. Camera Enclosure mounting hardware
    a. 1 5/8" wide Unistrut, length to be determined by customer, see next section (Qty: 2)
    b. 18-8 stainless steel screw ¼"-20 thread size, 5/8" length (Qty: 4)

    c. Stainless steel fender washer for ¼" bolt, 0.281" ID, 1.25" OD (Qty: 4)
2. Power Enclosure mounting hardware
    a. ¼" diameter (or 6 mm) mounting bolts or screws with matching flat washers (Qty: 4)
3. Ground wire to connect the Camera Enclosure ground lug to an appropriate external grounding point. The ground lug accepts a 14-AWG to 4-AWG wire. NWB Sensors recommends 12-AWG ground wire. Length is to be determined by customer.
4. As desired, 2" diameter conduit for cables connecting the Power Enclosure and the Camera Enclosure. (Conduit is not required. All cables are outdoor rated.)
5. Zip ties for cable management.

Required Tools

Gather tools needed to complete the installation:

1. Appropriate hex keys or socket wrenches for Camera Enclosure mounting hardware
2. Appropriate hex keys or socket wrenches for Power Enclosure mounting hardware
3. Flathead screwdriver
4. Phillips head screwdriver
5. Level. A digital level with 0.1° precision is preferred.
6. Tape measure
7. Optional:
    a. Cable snake/fish tape
    b. Square
    c. Pen/Pencil

Mounting the Camera Enclosure

Requirements

1. Must be installed with two people. (Enclosure weighs 35 lb.) One person to position the Camera Enclosure and the second to install the mounting bolts. This is to prevent an accidental drop that could damage the instrument.
2. Must be mounted outside with a clear view of the sky.
3. Must be mounted so that cables will comfortably reach between the two enclosures.
4. Must be mounted so that the cable connectors are on the bottom of the enclosure.
5. The Camera Enclosure is intended to mount to two vertically parallel slotted Unistrut channels. The two vertically parallel Unistrut channels have an inside spacing of 8.775" (-1/32" +1/8"). See Figure 2 below.

The Camera Enclosure

The Camera Enclosure is 16" x 12" x 8" (height x width x depth) as viewed from the front of the instrument with the access door. This aluminum enclosure has 8 mount points on the back located 8.0" (±2.0") x 10.4" apart (height x width). These mount points take a ¼"-20 x 5/8" threaded bolt. At least 4 mount points must be used, two on each side; however, it is recommended to use all mount points. Stainless steel socket head screws and washers are recommended for installation. The Camera Enclosure mounts on 1 5/8" wide Unistrut as shown in Figure 2. Half Slot type "A" is recommended, but type "B" is acceptable. The upper most Unistrut hole should be the upper most mounting hole, as shown in the diagram.

Clearances

Nothing should be mounted above the Camera Enclosure.
1″ of clearances on each side is required.
6″ of clearance is required below the enclosure to properly route cables.
12″ of clearance is required to the rear of the enclosure for proper ventilation.
12″ of clearance is required in front of the enclosure to accommodate the door when open.

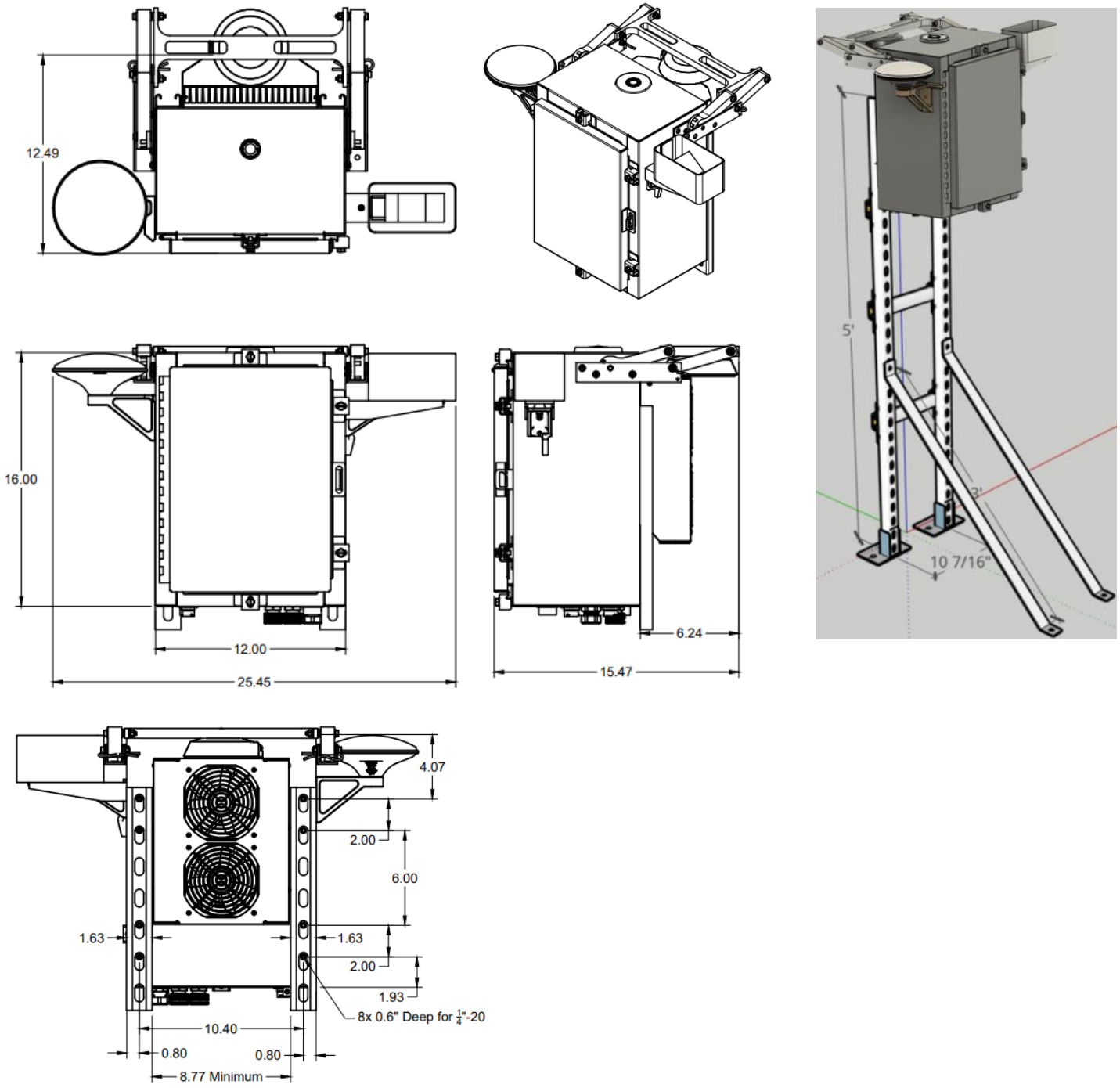


Figure 2. External dimensions of the ICI Camera Enclosure with GPS antenna option (upper left). Dimensions for mounting the ICI Camera Enclosure (lower left), Unistrut mount for the ICI (right). Note: The Unistrut photos on the right show a typical installation and are provided for reference only. Exact mounting configuration of the Unistrut is up to the user's discretion.

Mounting Instructions

1. If present, remove the ¼"-20 socket head screws installed on the back of the Camera Enclosure on either side of the heat sink and fans.
2. One person should hold the Camera Enclosure between the vertical slotted Unistrut channels so that:
    a. The fan shroud slides completely between both Unistrut channels until the back of the enclosure is flush against the Unistrut.
    b. The face of the Unistrut channel with the slots in it is flush against the back of the enclosure.
3. The second person should help the first position the Camera Enclosure so that:
    a. The top of the Unistrut does not extend above the fan shroud.
    b. At least four of the ¼"-20 screw holes in the enclosure's back can be seen through the Unistrut channel's slots (all 8 should be visible if using standard Unistrut).
4. While the first person continues to hold the Camera Enclosure in place, the second should install at least four ¼"-20 screws with fender washers into the Camera Enclosure until they are just snug.
    a. If using half height ("B" Channel) Unistrut the washers *may* need to be inserted from the top of the Unistrut and guided down. If so, starting with the lower mount points will be easier.
5. Use a level to ensure the enclosure is mounted level so that:
    a. The door of the enclosure will not swing shut when opened.
    b. The infrared camera can see the whole sky.
6. Fully tighten the four ¼"-20 screws once the level has been adjusted.

Figure 3. Photo from the back after mounting.

7. Using the flathead screwdriver, loosen, but do not remove, the four retaining latches on the door. Slide the latches out so that door can be opened.

Figure 4. Photo of the Camera Enclosure front. The four retaining latches around the door are identified by dashed orange circles.

8. If there is packaging material still in the enclosure, carefully remove it.
9. On the back of the enclosure door, install eight 45.5-gram blue silica gel reusable DriBox (desiccant) included with the ICI. See Figure 5 for an image of the installed desiccant.
    a. As needed, use a 3/32" Allen/hex key to loosen the 4-40 socket head screws on the desiccant holders. (Do not remove the screws.)
    b. Slide the desiccant boxes into the holder and gently tighten the 4-40 screws so that they are just touching the walls of the DriBox desiccant.
    c. Install Desiccant/DriBox retaining clips over the 4-40 screw heads and around the boxes to secure them in place

Figure 5. Installed DriBox desiccant on the back of the ICI Camera Enclosure door.

    d. The instrument ships with eight (8) additional DriBox desiccant packs which allow for maintenance. Store these with other maintenance supplies.
10. Close the door
    a. Tighten four latches until the door seal is compressed on all sides
11. Attach the user supplied ground wire to bottom of the Camera Enclosure using 14AWG to 4AWG wire (torque to 45 in-lbs) and to the external ground point. This connection provides EMI protection.

Figure 6. Images of the ground lug on the bottom of the ICI.

12. Remove hairpins from hatch arms and store them in the lower holes at the back of the hatch assembly. Figure 7 shows images of the hairpins in the stored position and indicates the shipping position.

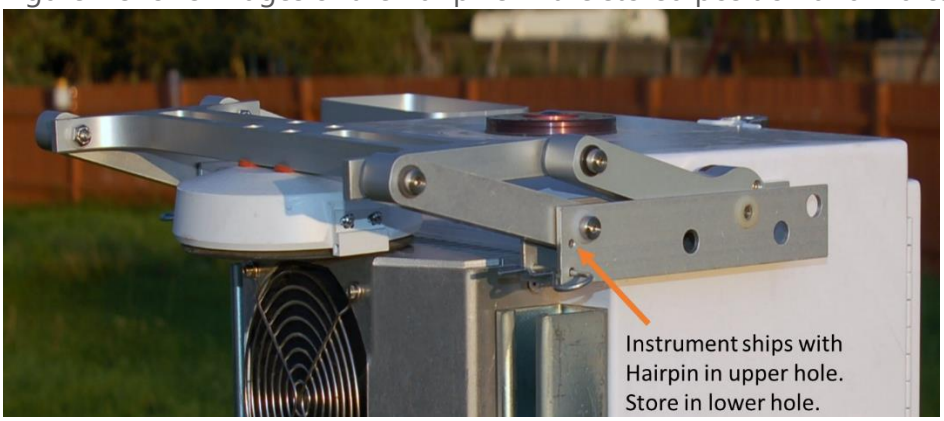


Figure 7. Image of the hatch hairpin locations.

Installing the Cable Connections

Requirements

1. Cable ends are keyed and, when aligned, will easily slide into place.
2. Each cable has a unique connector, so it is impossible to plug them in incorrectly. Do not try.
3. If conduit is desired, a minimum of 2" (nominal) diameter conduit is required. For ease of installation, 2.5" diameter conduit is recommended. One conduit can be used for all three cables.
4. When pulling the cables through the conduit, start with the cable that has the largest connector.

Instrument Wiring

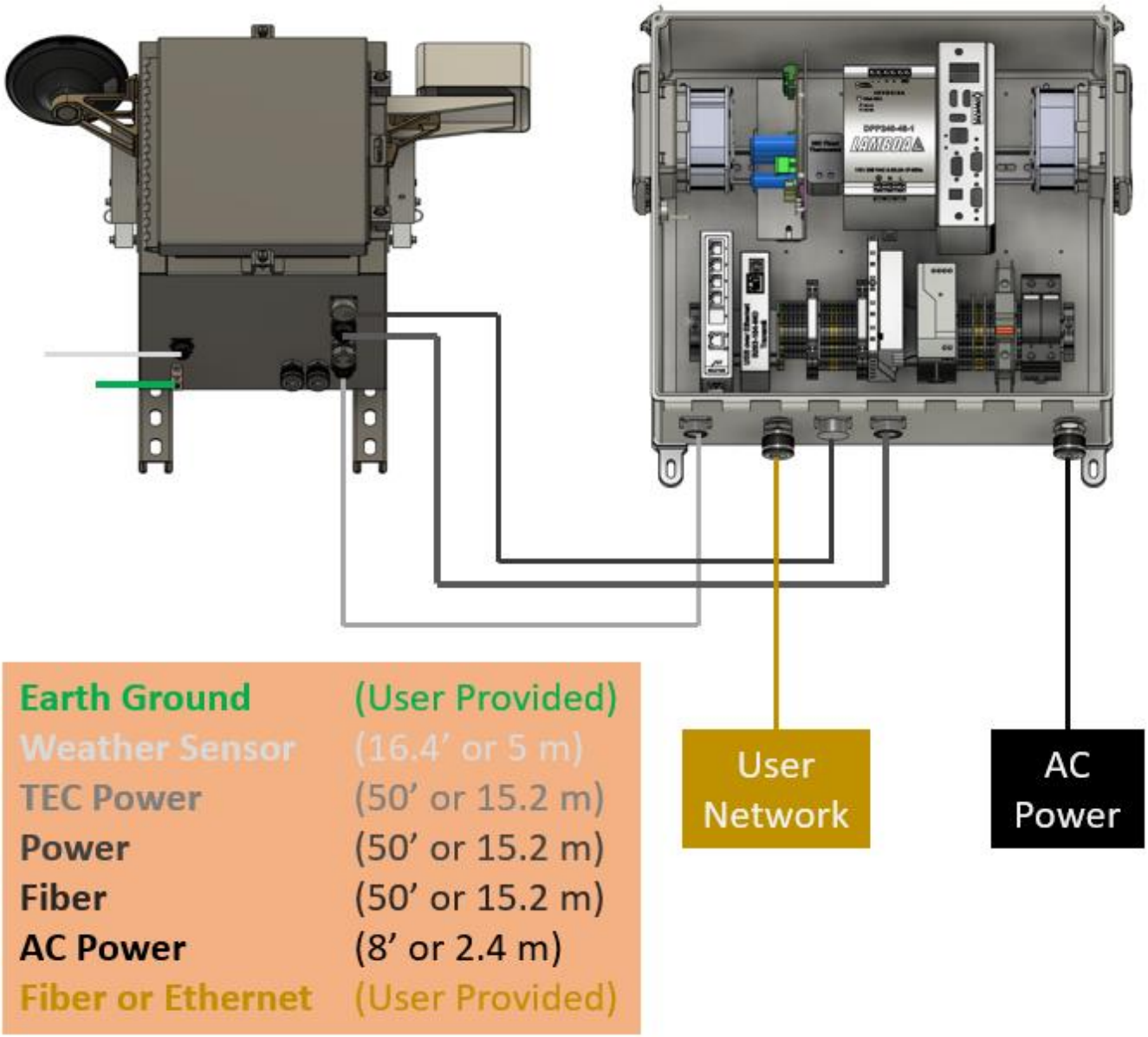


Figure 8. The ICI System Cables, note colors roughly match actual cable color. For simplicity integrated Camera Enclosure cables (GPS, Rain Sensor, External Fans) are not shown. Cable lengths are standard, but TEC, Power and Fiber can be customized up to 96' or 30 m.

Cabling Dimensions

The ICI cabling consists of three cables that run between the Power Enclosure and the Camera Enclosure. These are a gray multi-conductor power cable, a gray multi-conductor TEC-power cable (temperature control PWM signals), and a black data cable (fiber) which carries camera imagery and telemetry.

Cable Installation

1. If using conduit, pull each of the three cables through the conduit one cable at a time.
2. Remove the caps and save them for return shipping or maintenance.
3. Plug the cables into the Camera Enclosure. For each cable, align the key on the cable connector to the plug. Then, insert and rotate approximately ¼ turn until you feel the bayonet lock.
4. As needed, secure the cables with zip ties or by other means to reduce tripping hazards and cable wear.
5. **DO NOT connect cables to the Power Enclosure until it is mounted.**
6. **DO NOT power on system.**

Connector	Connector Diameter	Cable Diameter
Fiber	35 mm	4 mm
Power	30 mm	14 mm
TEC Power	27 mm	9 mm

Figure 9. ICI cable connector dimensions

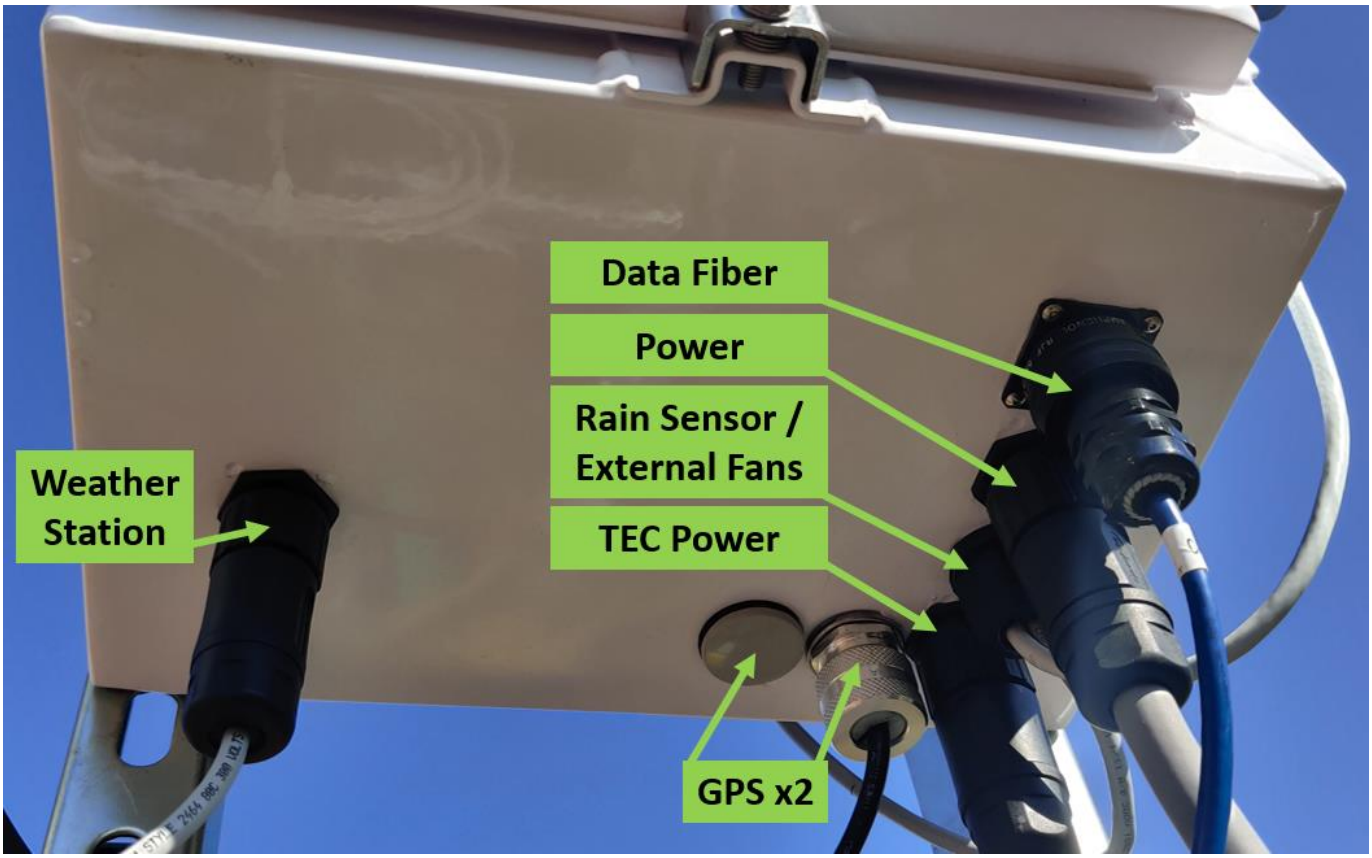


Figure 10. Camera box cable connections (shown with Weather and GPS options)

Mounting the Power Enclosure

Requirements

1. Must be installed with two people. (Enclosure weighs 25 lb.) One person should hold the Power Enclosure in place while the second person installs the bolts or screws to prevent an accidental drop that could damage the instrument.
2. Must be mounted within 8 feet of an AC outlet.
    a. **DO NOT** plug the AC power cord into the outlet until instructed to do so.
3. Must be mounted so that the cables will comfortably reach both enclosures.
4. Must be mounted inside a climate-controlled shelter building. The building environment must be maintained between 0-35 °C, noncondensing, moisture-free, and free of excessive dust.
5. Should be mounted with cable connectors on bottom of the enclosure.
6. Should be mounted with ¼" bolts or screws and flat washers or equivalent. The Power Enclosure should be mounted to a structure which can support 25 lbs. Unistrut, wood studs, or plywood (1/2" thick or greater) provide appropriate support. **DO NOT** mount the Power Enclosure to drywall.
7. Should be mounted level.

The Power Enclosure

The Power Enclosure is a 16" x 14" x 8.5" fiberglass box with four mounting points located at 15.64" (+/-0.39") x 15.13" (+/-0.05") (height x width) as shown in Figure 12. Each mount point accepts a ¼" bolt or screw. Mounting hardware is not included for the Power Enclosure, and the installer must provide appropriate hardware for the structure to which the enclosure will be mounted. Mount the Power Enclosure so that its 8-foot 14/3 120V AC power cord with a standard NEMA 15-5 3 blade connector can reach a properly installed power outlet.

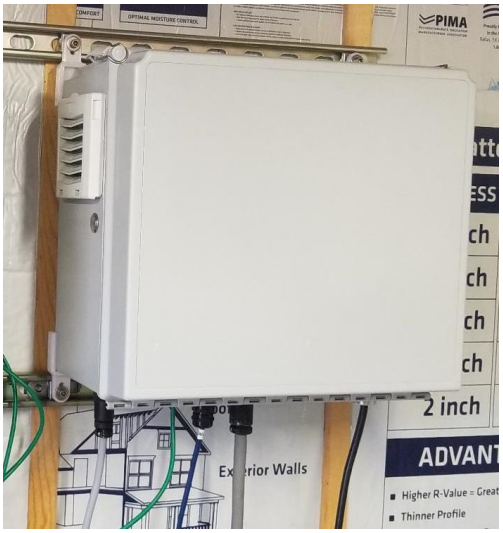


Figure 11. Example Power Enclosure installation on Unistrut across wood studs

Clearances

4" of clearances on each side is required for the ventilation fans to function properly.
2" of clearance is required above the top enclosure for the mounting feet and for accessing the latches.
22" of clearance is required from the mounting wall for the door to swing open.
15.5" of clearance is required beneath the enclosure to accommodate the door when open.

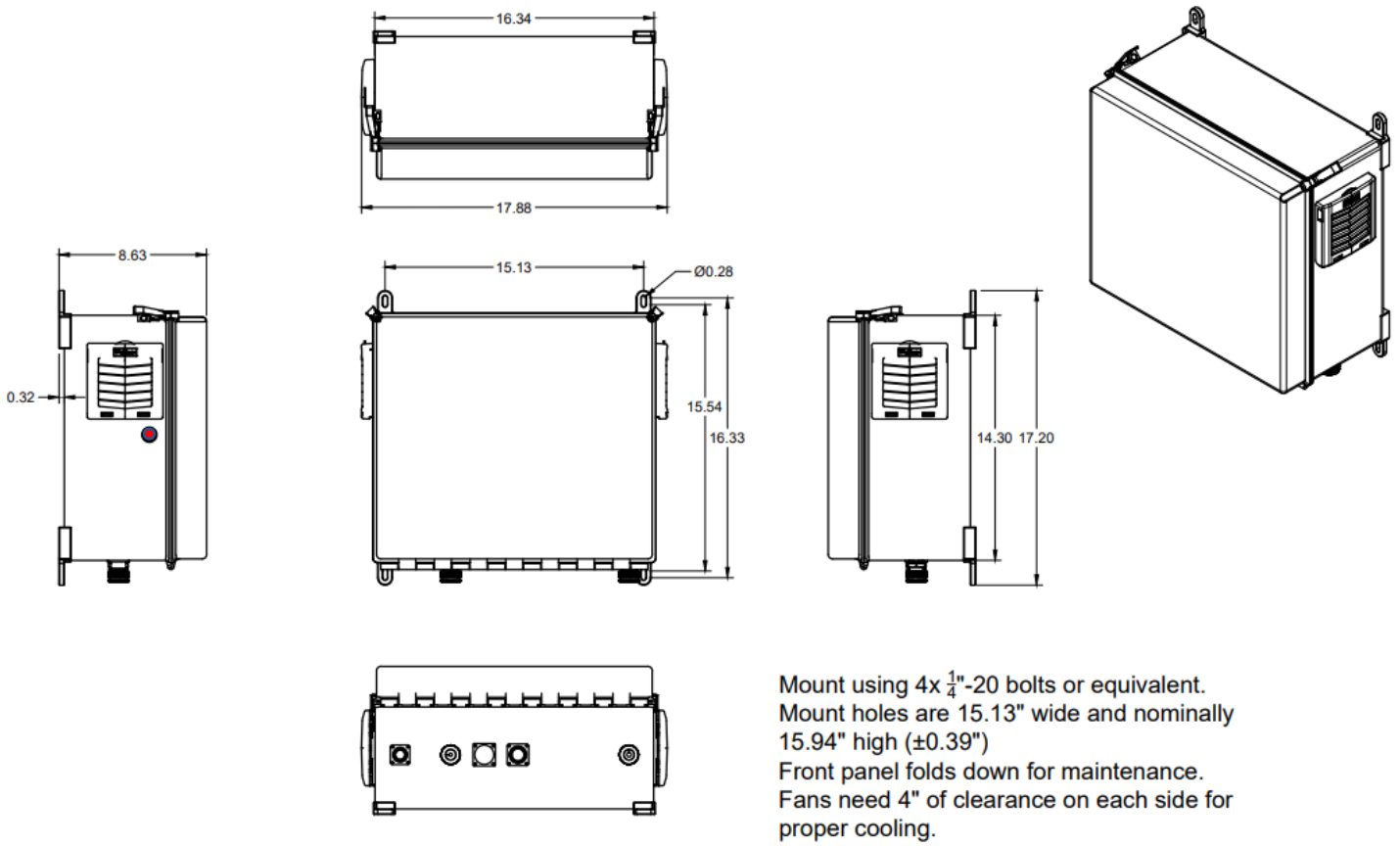


Figure 12. Power Enclosure dimensions. Hatch override switch (highlighted in red) must be accessible after mounting.

Mounting Instructions

1. Prepare Power Enclosure for mounting.
    a. If the ICI Power Enclosure is shipped without the mounting feet attached, use a Phillips head screwdriver to attach them to the box. There are two different styles of feet: one style accommodates the upper left and lower right corners, and the other style accommodates the lower left and upper right corners.
2. Mount points are spaced 15.64" (+/-0.39") x 15.13" (+/-0.05") (height x width)
    a. Use a tape measure, level, and square to ensure the mount points are level and square.
3. Secure all four mount points.
4. Open the Power Enclosure door by releasing the two latches on the top corners. The door will open towards you and down.
5. If there is packaging material still in the enclosure, carefully remove it.
6. Close the Power Enclosure door and secure the two latches on the top corners.
7. For each cable, align the key on the cable connector to the plug. Then, insert and rotate approximately ¼ turn until you feel the bayonet lock.
8. Remove the caps and save them for return shipping or maintenance just like the camera box.
9. Optionally secure the cables with zip ties or by other means to reduce tripping hazards and cable wear.
10. Do not connect the Power Enclosure to the AC outlet at this time. Perform the *Network Installation* described next.

Network Installation

The ICI needs to be connected to a local area network. This connection is made at a Blackbox switch that is internal to the ICI Power Enclosure. Figure 13 shows the setup. The Blackbox switch is mounted at the lower left of the enclosure, indicated by the red dashed box. The switch supports either an ethernet connection or a fiber connection. The BlackBox SFP module is the LFP411. See LFP411 datasheet for fiber requirements. With either setup, the network cable will pass through a cable gland indicated by the yellow dotted box in the left image and shown on the right images.

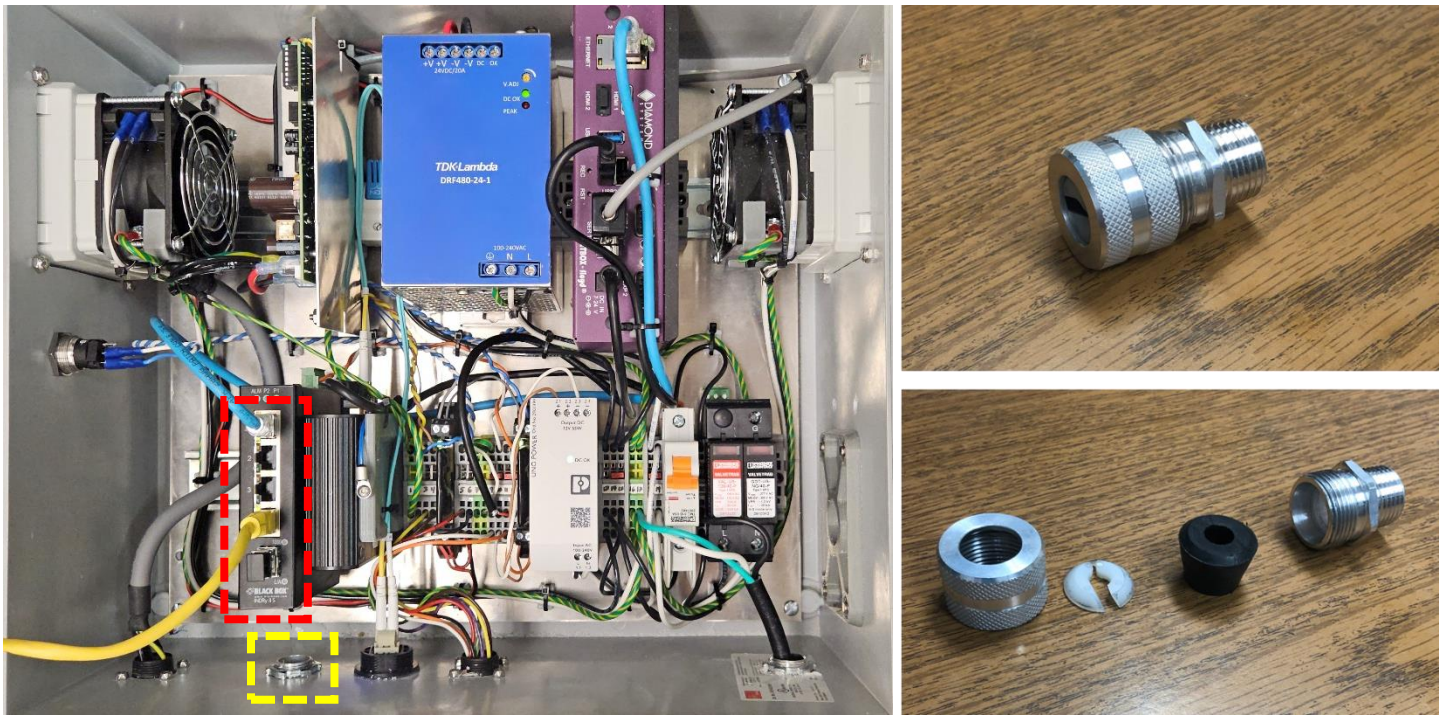


Figure 13. Inside the Power Enclosure showing switch (red dashed box) and cable gland (yellow dotted box) locations (left). Currently showing ethernet option (for testing), but not running through the gland. Image of cable gland (right top), and image of an opened cable gland (right bottom).

1. Open the Power Enclosure door by releasing the two latches on the top corners.
2. Install fiber optic or ethernet cable to the Blackbox network switch (inside the ICI Power Enclosure)
    a. Open the network connection cable gland by unscrewing the outer aluminum nut. The cable gland has three parts: the aluminum nut, the retainer clip, and the rubber seal (Figure 13, bottom right).
    b. Slide the cable through the aluminum nut and rubber bushing. If necessary, the bushing can be cut lengthwise if the cable end will not fit through. This is permissible since the Power Enclosure is not in an environment that needs strict water ingress protection around the cables.
    c. Plug the cable into the switch.
    d. Place the retainer clip between the aluminum nut and rubber washer.
    e. Tighten the aluminum nut by hand until the rubber seal is compressed just enough to seal around the cable. Do not overtighten.
2. Close the Power Enclosure door and latch the two latches on top corners.
3. Follow the startup instructions in the next section.

Starting the System

The ICI system starts automatically upon power up. To start the system, perform the following steps:

1. Connect the AC power cable attached to the Power Enclosure to a power outlet.
2. Open the Power Enclosure and ensure that the orange breaker is set to "On" (see Figure 14).
3. Confirm that the "DC OK" LED on the TDK-Lambda (DRF-480-24-1) power supply is lit.
4. If deploying in cold weather, the system will wait for the TEC system to warm the Camera Enclosure to approximately 5 °C before powering up the system. This may take up to 30 minutes. When temperatures are stable the green LEDs on the two relays will light up.
5. Confirm that the "DC OK" LED on the Phoenix Contact (2902999) power supply is lit. Then, allow 45 seconds for the embedded system to boot.
6. If any of these lights fail to turn on, contact NWB to discuss the issue.
7. Under dry conditions, the hatch will open approximately 2 minutes after booting.
8. Access the system through one of the software interfaces described in the *All-Sky Infrared Cloud Imager Software Operations Document* to verify operation. It is critical that the system be synchronized to an NTP server for proper operation of the instrument. Time synchronization should be checked immediately upon gaining access to the system. Also, for systems that use configuration to set the deployed location manually (as opposed to using the GPS), this configuration change must be made immediately.

In the event of a power failure, the ICI will automatically restart when power is restored.

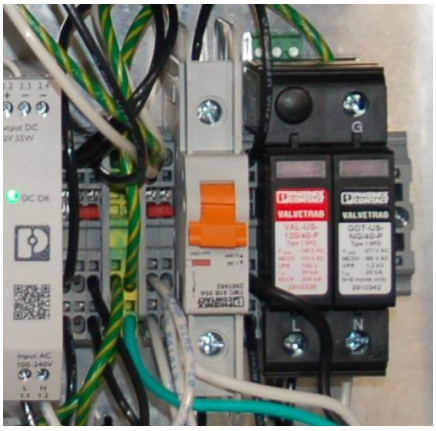


Figure 14. Orange breaker inside Power Enclosure shown in the ON position.