



Field Equipment

USER MANUAL

May 2020

NuSeis System

GEOPHYSICAL TECHNOLOGY INC | WWW.GEOPHYSICALTECHNOLGY.COM



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PRELIMINARY

Chapter 1 Introduction



PRELIMINARY

Overview

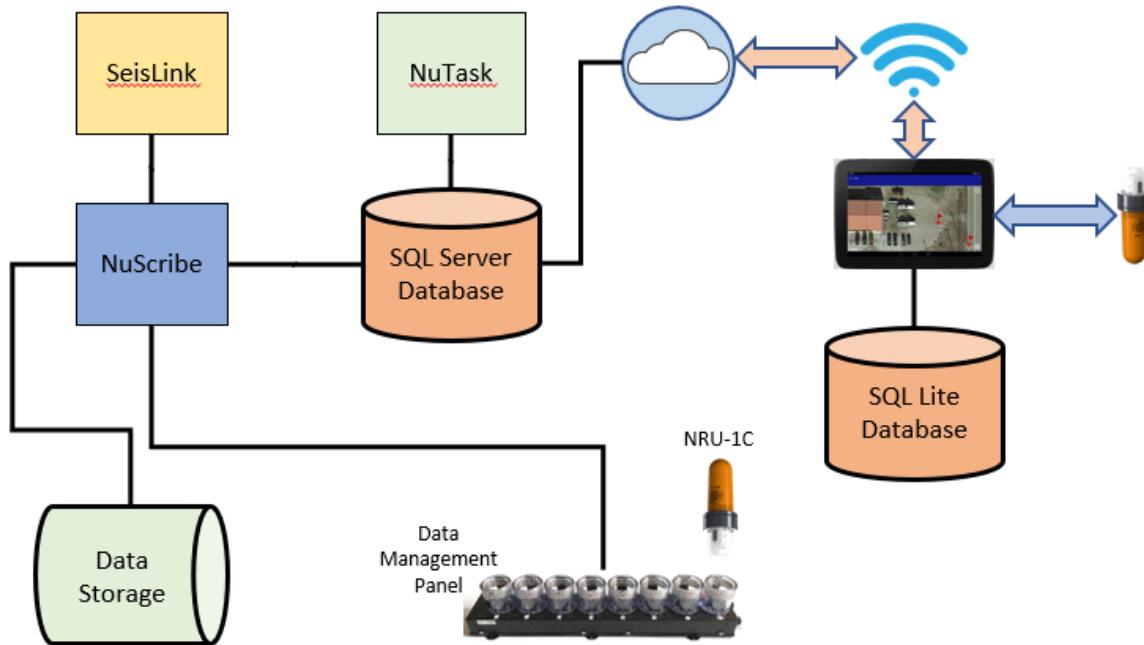


Figure 1

- The most important part of the NuSeis Ecosystem is the field equipment.
- The NRU-1C is deployed in the field to record seismic data.
- The data is recorded in proprietary format on a uSD card. The data is extracted and output in SegY format by NuScribe.
- Deployment of the NRU in the field can be done with several different methods.
- Manual deployment and retrieval tools can be used for most applications. A Powered Deployment Tool is also available for hard terrain.
- The ADS (automatic deployment system) allows for accurate quick deployment.
- NRU-KCK units have an external connector that allows for recording with external geophone string, hydrophone or recording of auxiliary channels from the recorder encoder.

Handling

- ❖ While the construction of the NuSeis field equipment is extremely rugged and robust, some of the equipment still contains electronic circuitry that could possibly be damaged by heavy physical shock and abuse.

- ❖ Handling of all NuSeis equipment should be done in accordance with precautions and instructions described in the NuSeis Manuals.
- ❖ NRUs should be handled with care. Avoid dropping or throwing the nodes to cause a heavy shock to be translated into the internal electronics. Use the prescribed transportation and handling methods, never transport the NRUs loose in a vehicle or box/bag that will allow the NRU to slam together during transport.
- ❖ During field operations, NRUs should always be transported in the provided NuSeis Bags, which are designed to protect the NRU during transport in a vehicle over rough terrain and/or by hand carry during man portable operations.

PLEASE NOTE

- ⇒ Any misuse or mishandling of any NuSeis equipment will void the manufacturer warranty and any required repairs will be at the buyer's cost.
- ⇒ No warranty shall apply in the event products are used outside their normal operating or handling conditions, or in case of:
 - lightning, fire, misuse, defective maintenance, negligence, fault
 - repairs that are not certified or completed by GTI
 - alteration or modifications by the customer or a third party
 - integration of components, sub-assemblies or assemblies non-certified by GTI into the products
 - connections to equipment or power / voltage sources non-approved by GTI.
- ⇒ Only GTI or GTI-certified personnel should open or repair NuSeis equipment.

Chapter 2 NRU-1C



User Manual Statement – FCC

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- 1. This device may not cause harmful interference, and*

2. *This device must accept any interference received, including interference that may cause undesired operation.*

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

To comply with FCC RF exposure limits for general population / uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm (7.9 inches) from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

NRU-1C M Series Specifications

| | |
|------------------------------------|--|
| Seismic Data Channel | 1 Component |
| ADC Resolution | 24-Bit Delta Sigma |
| Preamplifier Gain | Programmable 0dB to 42dB in 6dB steps |
| Anti-alias Filter | 206.5Hz @ 2ms, 413Hz @ 1ms |
| | Linear Phase and Minimum Phase |
| Operating Temperature Range | -40°C to +60°C |
| Weight | 0.862 kg, 1.9 lbs. |
| Dimensions | Max 50.5mm tube 299 mm long |
| | Max 1.988" tube 11.77" long |
| Battery | Type: 10ah Li-Ion |
| | Charging Time: ~6 hours from cutoff to 100% |
| | Charging Temperature Range: 0°C to 45°C ¹ |
| | Cycle Life: >500 cycles to 80% |
| Battery Longevity | ~384 Hours @2msec 12 hours/day: ~30 days 24 hours/day: ~16 days |
| Communication | Bluetooth (BLE low power) and USB or TransferJet Proximity |
| GNSS | Ultra-low power, multi-GNSS with multi-path detection and compensation Orbit prediction for fast TTFF PPS typical accuracy +/-10ns Sensitivity: Acquisition -148dBm cold / -163dBm hot Tracking: -165dBm |

| | |
|--|---|
| Acquisition Channel @2ms sample interval, 25°C, 31.25Hz | Maximum input signal: 1768mVrms @0dB Total Harmonic Distortion: 0.0001% @31.25Hz Instantaneous Dynamic Range @ 12dB gain: 123dB @ 2ms 121dB @ 1ms 119dB @ 0.5ms Equivalent Input Noise: 1500nV @ 0dB 400nV @ 12dB 160nV @ 24dB Gain Accuracy: 0.25% unit to unit Input Impedance: 20kohm Timing Accuracy: +/- 12.5usec GPS Time Standard: Better than 500ppb |
| Sensor Test | Resistance, Impedance, Noise |
| Sensor | Internal Single Geophone: 10Hz +/-3.5% 85.8V/m/s +/-3.5% Other geophones available on request |
| Internal Test | Impulse Response, Noise, Total Harmonic Distortion |
| Memory | 8GB standard (expandable to 16, 32, or 64GB) ~55 days @ 2ms ~27 days @ 1ms |

¹ Max charging temperature is protected by firmware, but care should be taken to only charge NRU that have cooled below 45°C.

NRU-1C N Series Specifications

| | | | | |
|--|--|--|--|--|
| Seismic Data Channel | 1 Component | | | |
| ADC Resolution | 24-Bit Delta Sigma | | | |
| Preamplifier Gain | Programmable 0dB to 42dB in 6dB steps | | | |
| Anti-alias Filter | 206.5Hz @ 2ms, 413Hz @ 1ms Linear Phase and Minimum Phase | | | |
| Operating Range | Temp. | -40°C to +60°C | | |
| | Altitude | 4572 m | | |
| | Humidity | 0-100% | | |
| | Immersion | IP68 | | |
| | Environment | Indoor, outdoor, arid, swamp, marsh, wetland, etc... | | |
| Weight | 0.693 kg, 1.53 lbs. | | | |
| Dimensions | Max 53.5 mm tube 209 mm long | | | |
| | Max 2.1" tube 8.23" long | | | |
| Battery | Type: 13.4ah Li-Ion | | | |
| | Charging Time: ~8 hours | | | |
| | Charging Temperature Range: 0°C to 45°C ² | | | |
| | Cycle Life: >500 cycles to 80% | | | |
| Battery Longevity | ~ 495 Hours @2msec 12 hours/day: ~ 42 days 24 hours/day: ~ 21 days | | | |
| Communication | Bluetooth (BLE low power) and USB | | | |
| Overvoltage Category | Device: Category I | | | |
| Pollution Degree | 2 | | | |
| GNSS | | | | |
| Ultra-low power, multi-GNSS with multi-path detection and compensation Orbit prediction for fast TTFF PPS typical accuracy +/-10ns Sensitivity: Acquisition -148dBm cold / -163dBm hot Tracking: -165dBm | | | | |
| Acquisition Channel @2ms sample interval, 25°C, 31.25Hz | | | | |
| Maximum input signal: 1768mVrms @0dB | | | | |
| Total Harmonic Distortion: 0.0001% @31.25Hz | | | | |
| Instantaneous Dynamic Range @ 12dB gain: | | | | |
| 123dB @ 2ms 121dB @ 1ms 119dB @ 0.5ms | | | | |
| Equivalent Input Noise: | | | | |
| 1500nV @ 0dB 400nV @ 12dB 160nV @ 24dB | | | | |
| Gain Accuracy: 0.25% unit to unit | | | | |
| Input Impedance: 20kohm | | | | |
| Timing Accuracy: +/- 12.5usec | | | | |
| GPS Time Standard: Better than 500ppb | | | | |
| Sensor Test Resistance, Impedance, Noise | | | | |
| Sensor Internal Single Geophone: 10Hz +/-3.5% 85.8V/m/s +/-3.5% <i>Other geophones available on request</i> | | | | |
| Internal Test Impulse Response, Noise, Total Harmonic Distortion | | | | |
| Memory 8GB standard (expandable to 16, 32, or 64GB) ~55 days @ 2ms ~27 days @ 1ms | | | | |

² Max charging temperature is protected by firmware, but care should be taken to only charge NRU that have cooled below 45°C.

NRU-1C Block Diagram

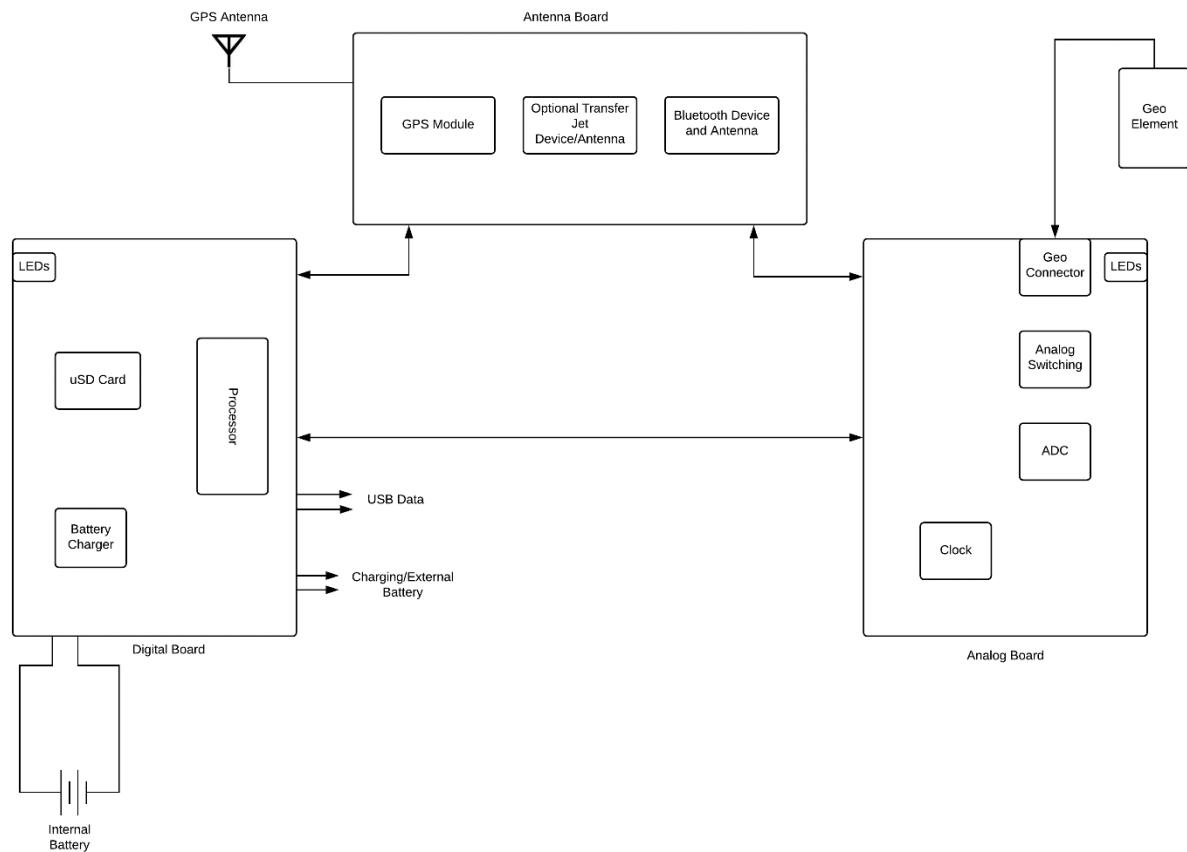


Figure 2

NRU-1C Description

Physical

- The case of the NRU-1C consists of 4 parts.
 - Bottom Assembly – a tapered high strength tube that encases the NRU clamshell assembly, battery, and geophone element. The shape and design enhance the NuSeis EarthGrip technology. The N Series bottom assembly is shorter and slightly broader in comparison to the M series bottom assembly
 - The joint between the Bottom and Cap Assemblies is solidly sealed by 2 O-rings.
 - Face Seal O-ring
 - Radial Seal O-ring
 - Cap Assembly – high strength clear plastic allows for full view of the high visibility LEDs in the NRU. The USB model incorporates 4 stainless steel MIMs, 2 for battery charging or connection of an external battery, and 2 for USB data. The optional TransferJet model incorporates 2 stainless steel MIMs for battery charging or connection of an external battery.
 - Bottom Clamp – the M Series utilized a stainless steel threaded ring used to secure the bottom assembly, the N Series has an aluminum bottom clamp
 - Top Clamp – the M Series has a stainless steel M60 hex nut used to secure the top assembly, the N Series has an aluminum or hardened plastic ring nut.

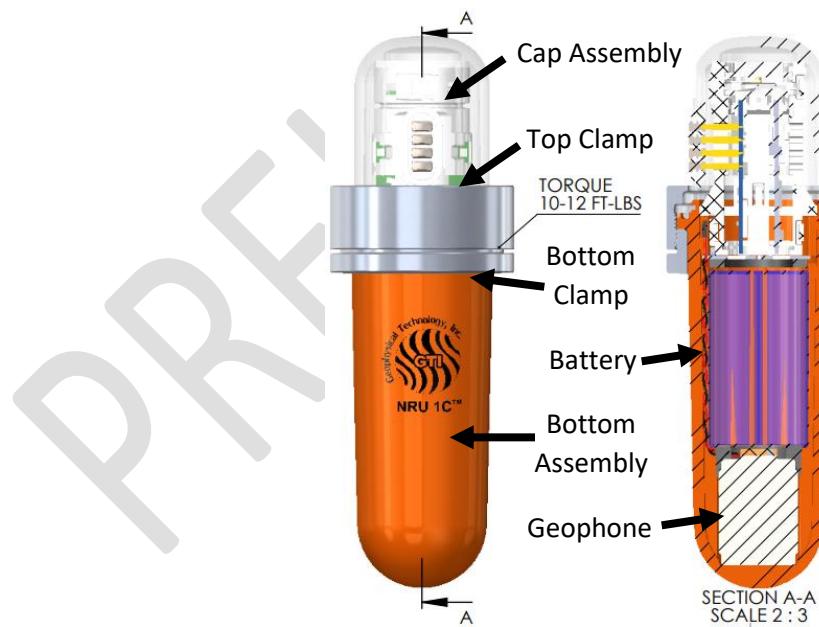


Figure 3

Power

- Internal battery

- M Series - 10Ah Li-Ion
- N Series – 13.4Ah Li-Ion
- The battery is protected by the rugged construction of the NRU assembly and by compression rings/sleeves.
 - Please refer to the NuSeis Technical Manual for information on battery maintenance/replacement.
 - Attempts to open the NRU/access the battery must never be carried out by anyone other than GTI or GTI-certified personnel.
 - Only certified/approved NuSeis battery packs are allowed for use in the NRU

CAUTION

RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE
DISPOSE OF USED BATTERIES ACCORDING TO LOCAL LAWS AND REGULATIONS

- Charger is built into the NRU. This allows charging by simply applying a DC voltage to the top assembly MIMs connectors. 12 to 15vdc can be used for charging purposes, 12vdc is optimal.

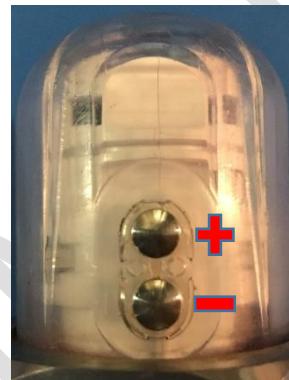


Figure 4

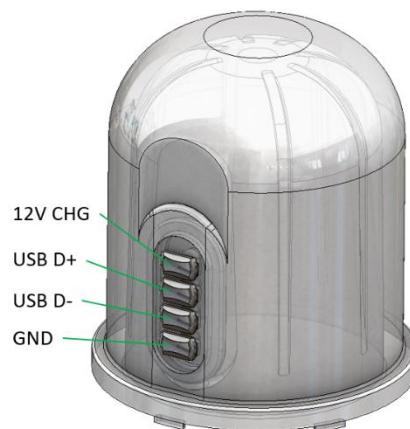


Figure 5

- An external battery may be connected to the NRU to charge the internal battery in the field, to top up the battery for extended recording times.

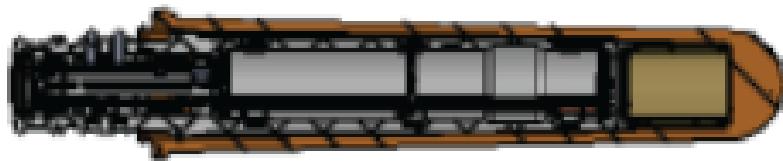


Figure 6

Geophone Sensor

- The NRU-1C has an internal single geophone sensor embedded in the bottom case.
- The location of the geophone and the design of the case incorporates the EarthGrip technology.
- The normally supplied geophone is a SunFull High Sensitivity PS-10R. Other sensors are available upon request. Most common industry utilized geophone elements will fit in the NRU assembly.

- PS-10R specifications:

| Parameter/Mode | PS-10R(20°) |
|---|-----------------|
| Natural Frequency(Hz) | 10±3.5% |
| DC Resistance(Ω) | 1800±3.5% |
| Sensitivity(V/m/s) | 85.8±3.5% |
| Sensitivity With Shunt Resistor(V/m/s) | 78.7±3.5%(20kΩ) |
| Damping | 0.48-0.54 |
| Damping With Shunt Resistor | 0.7±6% (20kΩ) |
| Distortion(%) | ≤0.1 |
| Max.Motion (mm) | 2.54 |
| Moving Mass(g) | 14 |
| Dimensions(d×h)mm | 30.2×39.9 |
| Max.Tilt Angle for Distortion Specification | 10° |

Figure 7

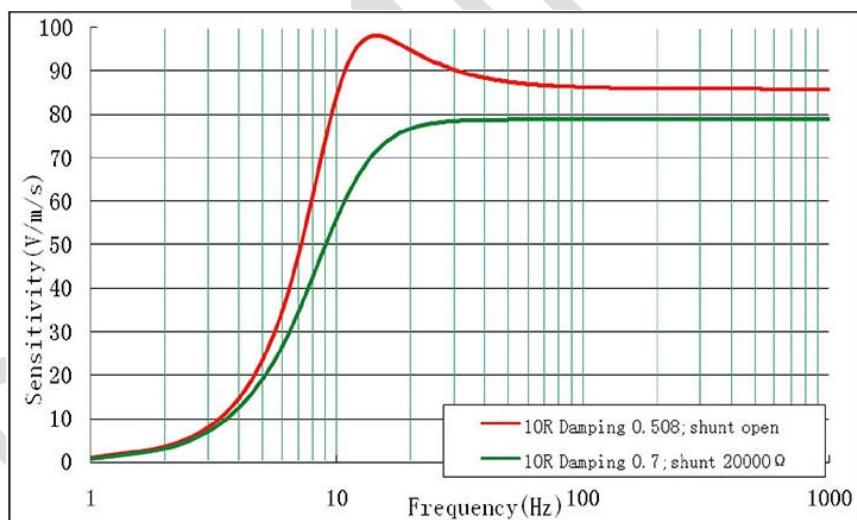


Figure 8

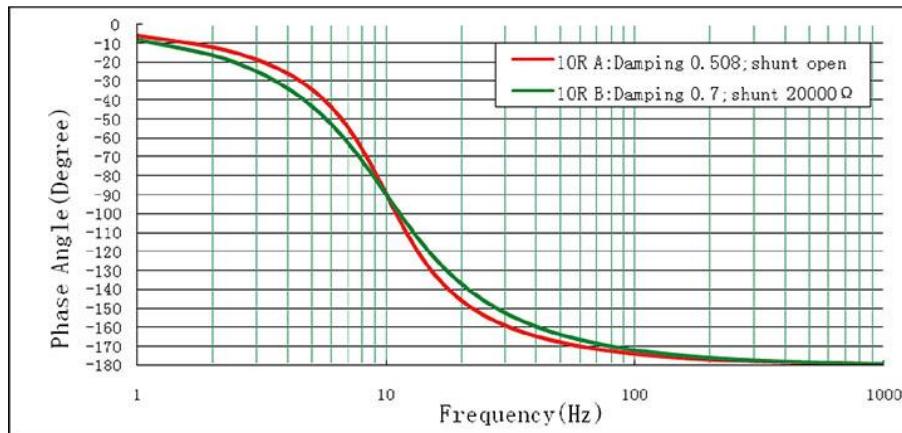


Figure 9

- A rubber grommet is used on top of the geophone for compression of the geophone into the bottom case of the NRU.
- Resistance, impedance, noise and distortion tests ensure the quality of the geophone sensor. LED indicators and NuSite tools help QC the test results.

Hardware

- The NRU electronics are protected by a 2-part clamshell, as well as shock absorbing compression rings and the high strength design of the case assembly.
 - The M series clamshell also encompasses the battery.
 - The N series clamshell encompasses the electronics only.
- See the [electronic block diagram](#).
- There are 4 boards.
 - Antenna Board (AB)
 - BLE Bluetooth device and antenna. Used for status broadcasting and NuSite communications
 - Optional TransferJet device and antenna. For data uploading, parameter and firmware programming wirelessly
 - GPS module and connection to the GPS antenna
 - Serves as motherboard for digital and analog board interconnection
 - Digital Board (BB)
 - LED status indicators
 - Connector for the internal battery pack.
 - Battery charging circuit, including the pogo connections to the Cap Assembly Charge MIMs.
 - USB circuit, including the pogo connections to the Cap Assembly USB MIMs.
 - uSD card. Stores the seismic data in proprietary format. Easily swappable
 - Processor
 - Analog Board (TB)
 - LED status indicators

- Connector for the geophone input
- Analog switching for the geophone input circuitry
- A to D converter
- High precision clock circuitry
- GPS Antenna Board

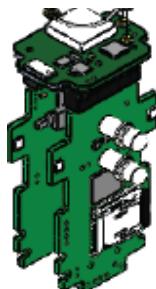


Figure 10



Figure 11



Figure 12

LED Status

- Highly visible LEDs indicate status of the NRU.

| Status | LED | | | | | |
|----------------------------|---|-----------------------|--------------------------------|---------------------|---------------------|---------------------|
| | Green | Blue | White | Yellow | Purple | Red |
| Fully Charged Battery | Solid till removed from charge | - | - | - | - | - |
| Geophone Testing Pass | 5 - 1 sec blinks | - | - | - | - | - |
| Valid Deployment | 5 - 1 sec blinks | - | - | - | - | - |
| BLE Startup | - | - | 2 sec solid | - | - | - |
| Geophone Testing | - | - | 1 sec blink till complete | - | - | - |
| Bump On From Shelf | - | - | 1 sec blink | - | - | - |
| Auto-Deploy Bump | (2 nd) After 10 sec, 5 blinks | - | (1 st) 2 sec blink | - | - | - |
| BLE Connected to NuSite | - | Solid while connected | - | - | - | - |
| Charging Battery | - | - | - | 4 second blink | - | - |
| Top-Off Charging | Continuous 4 sec blink | - | - | - | - | - |
| Valid Un-deployment | - | - | - | 5 - 1 sec blink | - | - |
| Going into Shelf Mode | - | - | - | Solid until shelved | - | - |
| Data connection lost | - | - | - | - | 1 sec blink forever | - |
| Failed Deploy or Un-deploy | - | - | - | - | - | 5 - 1 sec blink |
| Failed Geophone Test | - | - | - | - | - | 2 sec blink forever |
| NRU Error | - | - | - | - | - | 2 sec blink forever |

LED Chart

NRU-1C Preparation

Cleaning

- Make sure that the top caps of the NRUs are clean and free of mud or wet material, or a large amount of dust.
- Dust can be removed using a dry brush or rag.
- Mud can be washed off with clean water and a brush. **Do not pressure wash the NRUs.**
- A very light soap/water mixture can be used to wash the NRUs but must be rinsed off with clear water.
 - **Never use CRC or any other type of aerosol cleaning agent to clean the case of the NRU. Use of an aerosol cleaner or chemical cleaner could result in damage to the case.**
- Let the NRUs dry off prior to charging or downloading.

Charging

- See the sections for use of the [Charging Panel](#) and [Portable Charging Case](#).
- Ensure that the NRUs are clean as stated in the section above.
- The NRU LEDs will blink yellow while charging
- The NRU should charge until the LEDs switch to a blinking green color. This indicates the battery is charged to ~90%. The charger will now apply a top off charge to complete the charging.
- Once the battery has fully charged, the LED will change to a solid green.
 - **If an NRU shows yellow blinking LEDs for over 12 hours, or never blinks yellow when charge current is applied, the NRU should be removed from charge and checked for defects.**

States

- Deployed – in this state the NRU is active. The NRU is recording seismic data, GPS receiver is on at intervals, system clock is locked, and status is being broadcast via BLE.
 - This state can be set during offload, parameter programming or by NuSite in the field. See NuSite manual [Deploy/Undeploy section](#), NuScribe manual [Appendix B](#).
 - During commissioning an NRU can be put into a deployed state then shutdown. In this case, the NRU will need to be bumped first, but will power up in a deployed state after acquiring GPS and running internal tests. If commissioned in the Deploy state, the NRU will not deploy after being undeployed.
 - An NRU should never be moved in a Deployed state. Always undeploy an NRU before moving it to another location. An NRU can also be undeployed then shutdown for long moves.
- Auto-Deploy – Deploys when bumped from low power or shutdown state. Auto-Deploy can be used as an alternative to NuSite deployment, if NuSite is not being used on the project (line and station being assigned in NuScribe) or if the NuSite devices will be used well after deployment of the NRU.

- Requires a [bump](#) to bring the NRU up to full power state.
- White LEDs will show on the NRU for approximately 2 seconds after the bump.
- After 10 seconds, if the NRU is vertical and upright, and the accelerometer detects no movement for an additional 3 seconds, the NRU will flash a green LED 5 times indicating a successful deployment. Successful deployment in this case means that it has started the process of acquiring GPS data.
- The NRU will then go through the typical routine of acquiring GPS and getting System time lock, then doing internal tests. The LED will flash green 5 times indicating good internal tests and recording will start.
- An NRU that is set in Auto-Deploy state, can be undeployed or shutdown, and will return to a deployed state after a bump.
- Undeployed – in this state the NRU is partially active. The NRU is not recording, the GPS receiver is in a low power mode, the system clock is not locked, status is being broadcast.
 - This state can be set during upload or commissioning, NuScribe manual [Appendix B](#).
 - Use NuSite in the field to Undeploy, see NuSite manual [Deploy/Undeploy section](#).
 - To undeploy in the field without NuSite, pick the NRU up and hold it in an upright position for 2 seconds. Turn the NRU upside down. Hold it steady upside down for 3 seconds. The yellow LEDs will blink 5 times indicating that the NRU has undeployed.
 - If for some reason the NRU doesn't indicate a successful undeployment while upside down, repeat the procedure, but make sure to be very steady in the movement from upright to upside down.
 - The NRU will not undeploy if it senses movement.
- Shutdown – powered off. This can be done during data upload, commissioning, or with NuSite in the field. See NuSite manual [Shutdown/Cannot Shutdown section](#), NuScribe manual [Appendix B](#).
 - To take the NRU out of shutdown mode, it will either need to be bumped or placed on charge.
 - For normal operation, GTI suggests to only use Shutdown for transport/shipping or for storage. Typically during seismic operations the NRUs would not need to be Shutdown, only set as Undeployed or set to low power state after commissioning.

Commissioning

- See the NuScribe manual [Rack View section](#).
- Parameters for the current project will be set during commissioning.
- Firmware levels can be checked and corrected if not current. This should only be done at the start of a project. Typically firmware levels should not change during a project unless specifically instructed by GTI.
- Setting the mode and state of the NRU at the end of commissioning or uploading is an operational decision.
 - Many variables can come into play when deciding which mode to set the NRU to. For example, storage time after programming, recording time required, days in the field, roll requirements, etc.

- The NRU should be placed in Shutdown mode if it is to be stored for a long period or if being readied for transport/shipping.

Bumping

- When an NRU has been placed in Shutdown or an Auto-Deploy low power state, turn it back on or bring it up to a fully On state by bumping.
- Bumping involves momentarily touching a DC voltage to the power contacts on the cap assembly.
- The DC voltage can be between 6 and 12 volts, i.e. a 9-volt battery. Polarity must be observed. Positive terminal is on the top MIM, with the NRU upright. Reversing the polarity will do no harm, but the NRU will not bump on.
 - M series NRUs can be bumped with a 9 volt battery or a Bump Tool
 - N series NRUs should not be bumped with a 9 volt battery as the pins are too close to allow reliable bumping. Only the supplied N Series Bump Tool should be used.
- For an NRU that is bumped when in a low power Auto-Deployed state, it should go through the following sequence.
 - White LEDs will show on the NRU for approximately 2 seconds after the bump.
 - After 10 seconds, if the NRU accelerometer detects no movement for an additional 3 seconds, the NRU will flash green LEDs 5 times indicating a successful deployment.
 - The NRU will acquire GPS and System Clock and GPS clock will lock.
 - The LEDs will start flashing white continuously, for approximately 45 seconds, indicating that internal tests are running.
 - Green LED will flash 5 times indicating recording has begun.
- ⇒ An NRU cannot be bumped when the CPU is in an Active state, as seen in the NuSite Unit Status field. For instance, if an NRU has just been undeployed, or has just come off charge, the CPU will be active.
 - If a NuSite device is available, monitor the Unit Status field until the CPU shows as Inactive, then battery bump the NRU.
 - If no tablet is available, wait a short time and try the battery bump.
 - If Deploying with the NuSite device instead of a battery bump, you will not need to wait for the CPU Active status to change. Deployment can be done immediately without waiting.
- When a Shutdown NRU is bumped on
 - If Shutdown in a Deployed state.
 - White LEDs will flash once for 2 seconds indicating that the NRU is turning on.
 - The NRU should be quickly placed in the ground
 - The NRU will acquire GPS and System Clock and GPS clock will lock.
 - The LEDs will start flashing white continuously indicating that internal tests are running.
 - Green LED will flash 5 times indicating recording has begun.
 - If Shutdown in an Undeployed State, and commissioned with the Deploy option
 - White LED will flash

- The NRU will have to be Deployed with a NuSite device before it will start to acquire GPS and subsequently start to record.
- If shutdown in undeployed state, and commissioned with AutoDeploy option
 - White LED will flash
 - Green LED will flash 5 times
 - NRU will acquire GPS and go through self tests, flashing white LEDs
 - Green LED will flash 5 times as it starts recording

Bump Tool

- The bump tool consists of a hard plastic cup similar to the Data Management and Charge Panel cups. There is a plastic enclosure connected to the bottom of the cup which contains the 9V battery.



Figure 13

- The tool is used by sliding it onto and off of the NRU in a smooth motion.
 - Make sure the spring rings of the tool are not damaged
 - Align the tool with the NRU and keep it straight in line with the NRU during use.
 - Do not hold the tool on the NRU as the NRU will detect the voltage as a charge voltage and will not Auto-Deploy as it will configure itself for charging and not recording.
 - Bumping should be done in 1 smooth motion onto and off of the NRU in 1 motion.
 - Do not slam the tool onto the NRU as that could damage the tool.
 - Battery voltage should be checked daily to ensure the battery has not drained too much.



NRU-1C Field Use

Laying Out

- The NRU should be placed as close to the receiver point pre-plot position or surveyed flag as possible.
- The NRU can be planted by using the ADS (Automated Deployment System), a manual deployment tool, or a powered deployment tool.
 - All methods solution a hole in the ground that perfectly fits the NRU lower end for excellent EarthGrip coupling.
 - The ADS will automatically plant an NRU.
 - With the manual deployment tool, the NRU will need to be placed in the hole by hand and the top of the NRU stepped on with a foot to secure the plant. (Do not stomp on the NRU as that may cause foot or leg injury).
 - Depending on how hard the earth is, a combination of powered and manual deployment tool can be utilized. Drill a pilot hole with the powered deployment tool, then solution the hole with the manual deployment tool. Alternatively, solution the hole with the powered deployment tool alone.

- The optimal depth for the NRU to be planted, is with the bottom of the bottom clamp level with the top of the ground. The NRU can be planted down as far as having the top of the top cap below the surface and a thin layer of sand placed over it, so the unit is not visible.
- As with most seismic sensors, the closer to perfect vertical placement the better. Care should be taken when planting, not to deviate from vertical.



Figure 14

- If the NRU is in Shutdown or Auto-Deploy state, it should be bumped on prior to placing it in the ground. Make sure that the bump was successful by watching the LEDs for a single white blink during the bump, then quickly plant it.
 - For an NRU that was **not** commissioned in AutoDeploy state, once it is bumped on it will need to be manually deployed next. See the NuSite manual [Deploy/Undeploy section](#).
 - For an NRU that is shutdown in a Deploy state, once it is bumped on it will need to have the line and station numbers assigned either with the NuSite tablet, or in NuScribe after scan sync or download. See [Appendix A Deploying an NRU with NuSite section](#) of the NuSite manual for Edit Deployment.
 - Ensure that the NRU is planted immediately after bumping to avoid having the geophone tests fail due to the NRU being moved around during the tests.
 - A green LED will indicate that all tests have passed, and the NRU is recording.
 - A check should be made on the NuSite device being used for deployment, that there are no errors indicated for the NRU.
- When an NRU goes to the line without being shutdown and is in a low power Auto-Deployed or Un-deployed state, then either assign line and station, or deploy and assign line and station. Refer to the NuSite manual [Deploy/Undeploy section](#).
 - A check should be made on the NuSite device being used for deployment, that there are no errors indicated for the NRU.
- When an NRU is in a Deployed state, it is broadcasting status messages. Any NuSite device within BLE range of the NRU will record that status into its database.
 - It is recommended that each NRU be revisited with a NuSite device regularly, after deployment at a receiver point, to collect updated status. Regularity of the revisits would be dependent on operational considerations.

- The longer an NRU is deployed in a location, the better the accuracy of the GPS position being recorded in the node. Collecting that GPS position contained in the NRU status with the NuSite device improves the accuracy of the NuScribe databases for later transcription of data.
- Connecting an external Bluetooth GNSS device to the NuSite device will increase the accuracy of the positioning being stored.
- Revisiting NRUs to collect status also improves spread QA/QC.

Picking Up

- Use the retrieval tool to dislodge the NRU from the ground. **DO NOT HAMMER ON THE NRU TO DISLodge IT.**
- When picking up the NRUs, they can be undeployed in 2 different ways, either undeploy with a NuSite tablet (refer to the steps in the NuSite manual [Deploy/Undeploy section](#)) or remove the NRU from the ground and turn it upside down until the yellow LEDs flash (see the [Undeploy](#) section). Undeployment is very important information that is gathered with the NuSite database and also in the NRU ancillary data and is synchronized to the NuScribe database for use during SegY generation.
 - There may be circumstances that require an NRU to roll through several receiver point locations prior to having data uploaded. In this case, undeployment is extremely important between station locations for later data uploading and SegY generation.
 - Never move an NRU that is still deployed and recording, to another location. Always undeploy it first.
- It is not recommended to shut down the NRUs during pickup, but if it is required for operational reasons, refer to the NuSite manual [Shelf/Cannot Shelf section](#) for the proper steps. Please take note of the cautions for those steps.
- During un-deployment, a NuSite device carried with the pickup crew will receive updated status from each NRU it visits before and after each unit is un-deployed.

Uploading

- Ideally each NRU should be brought back, after it is picked up, to the location of the NuScribe computer and the Data Management Panels to upload data from the NRUs.
 - As noted in the section above it may be, for various operational reasons, that the NRU could roll through several receiver points prior to upload.
- Prior to uploading, ensure that the top caps of the NRUs are clean and free of mud or wet material, or a large amount of dust.
- Dust can be removed using a dry brush or clean towel.
- Mud can be washed off with clean water and a brush. **Do not pressure wash the NRUs.**
- A very light soap/water mixture can be used to wash the NRUs if necessary but must be rinsed off with clear water.
- Let the NRUs dry off prior to insertion into the Data Management Panel.
 - **Never use CRC or any other type of aerosol cleaning agent to clean the case of the NRU.**

- Use of an aerosol cleaner or chemical cleaner could result in damage to the case.
- Follow the Uploading process as described in the NuScribe manual [Rack View section](#).

Chapter 3 NRU-1C-KCK



NRU-1C-KCK Description

- The KCK model of the NRU is the same as the NRU-1C discussed in the last chapter, except there is no geophone element embedded in the case.
- The KCK model has an industry standard KCK style 2 pin threaded watertight connector built into the case in the place of the geophone element.



Figure 15

- The electronics boards and specifications are the same as the NRU-1C, except for the geophone.
- This model allows users to connect their own geophone string or hydrophone to the NRU.
- The KCK model can also be used to record the auxiliary signals from the source encoder unit, i.e. Timebreak, Pilot, etc.....
- This model can also be used in the field with the sources to capture source signals. Vibrator hardwires can be recorded as well as the signals needed for HFVS or other specialized Vibroseis operations that require the capture of source signals.
- Commissioning, uploading and charging procedures are the same as for the NRU-1C nodes.
- Deployment, Auto-Deploy and Un-Deployment are all the same as the NRU-1C, except that when bumping a KCK unit that is in Auto-Deploy mode the user may lay the unit on its side, after it has started searching for GPS.

- If being used in a swampy area or shallow water with marsh phones or a hydrophone, the KCK unit can be hung from a tree, pole or tripod if necessary, or even floated on a buoy.

PRELIMINARY

Chapter 4 NuSeis Bag

The logo is a red rectangular patch with a textured background. It features the text "Geophysical Technology, Inc." in a small, thin font at the top, "GTI" in a larger, bold font in the center, and "NRU 1C™" at the bottom.

NuSeis Bag

- The NuSeis bag is specifically designed to ergonomically transport the NRU1C units and at the same time protect them from physical shocks during transportation.
- There are 2 different sized bags, for both the M series NRU and the N series NRU.
- Each bag will hold 10 NRUs, 2 rows of 5.



Figure 16



Figure 17



Figure 18

- Drain grommets spaced along the bottom of the bag allows for drainage if water or mud gets in the bag from dirty NRUs. The drains also make washing dirt and mud out of the bags during cleaning.
- The bags should be carried using the padded shoulder strap. There are also side handles on newer versions of the bag to be used for moving the bags short distances.
- The NRUs should be stowed in the bags in an upright position for transport.



Figure 19

Chapter 5 Data Management Panel (DMP)



USB Data Management Panel

Panel Overview

- Each USB Data Management Panel can upload or commission 8 NRUs.
- By using multiple Data Management Panels, the NuScribe computer can upload or commission many NRUs simultaneously.
- The Data Management ports are hard plastic cups with 4 metal spring rings. 2 springs are used for turning on and charging the NRU during upload and commissioning, and 2 springs are used for USB data communications during upload and commissioning.
- The cup connectors are numbered 1 to 8. Number 8 is always at the end of the panel that has the ethernet ports and power connector.
- The panel has 2 ethernet ports, corresponding to the 8 cup connectors (4 cup connectors per ethernet port) of the panel.
- The 2 ethernet ports connect to a 10Gb (or faster) switch which is used to interconnect other Data Management Panels and the NuScribe computer.
- The USB data rate of each cup connector is 14 MB/sec. This corresponds to 56 MB/sec for each ethernet port, (4 cup connectors per port).

- The power connector is next to the ethernet ports. It is a 4-pin connector. Power input is 12vdc.
- The panels can be wall mounted, rack mounted, or portable case mounted. See the [Portable Case](#) section for information on the Portable Data Management Case.



Figure 20

Data Management Panel Use

- To carry out NRU uploading or commissioning operations, the panel must be connected to a NuScribe computer via the ethernet ports and a network switch. The size and speed of the switch depends on how many DMPs are connected, and how quickly data needs to be downloaded.
- The NRUs should be clean prior to loading into the panel. Muddy or wet NRUs need to be cleaned and allowed to dry.
- Once the NRUs are loaded into the Data Management ports, follow the NuScribe manual directions for either upload or commissioning. See NuScribe manual [Rack View section](#).



Figure 21

- The ports should be checked for a buildup of dirt and debris in the bottom of the cups. Too much dirt or debris may keep the NRU from turning on or communicating properly due to the debris obstructing proper seating.

- Remove power from the panel
- Use compressed air, preferably with a line dryer, to blow out the cups.
- Cleaning may also be done using a vacuum cleaner.
- A dry soft brush can be used to loosen debris in the cup prior to blowing it out with compressed air.
- **No CRC or other aerosol cleaning sprays should be used to clean the cups. The accelerant may damage the cups.**
- The NRUs should be inserted individually. **The nodes do not need to be oriented as the springs allow connections around 360°.**
 - Insert the NRUs as straight as possible. A straight up and down insertion of the NRUs will avoid damage to the connector cups.
 - Use a firm straight downward pressure to push the NRU down onto the panel.



Figure 22

- When initiating an upload or commissioning sequence, if an NRU fails the Connect step with a “Failed to receive NRU status” error, the NRU may not be contacting the springs of the cup.
 - When Charge On is applied to a cup, it will act as a charge panel cup. The NRU will blink a white LED at first, then start blinking a yellow LED indicating charging.
 - The NRU must detect a charge voltage during uploading or commissioning.
 - Verify the NRU is seated properly in the slot. If not, pull the NRU out, and seat it again firmly into the slot.
- Once upload or commissioning has finished, the NRUs can be removed from the panel.
- ***Do not operate a panel if there is any physical damage to any of the cup connectors, especially involving the springs.***
- ***Do not apply power to a panel that has a damaged/broken power connector.***
- ***It's preferable to not remove or insert NRUs in the cup connectors with Charge On applied to the cup connectors. To prevent accidental shorting, select Charge Off or All Off before removing or inserting the NRU.***

Optional TransferJet Data Management Panel

Panel Overview

- Each TransferJet Data Management Panel can upload or commission 8 NRUs.

- By using multiple Data Management Panels, the NuScribe computer can upload or commission many NRUs simultaneously.
- The Data Management ports are hard plastic cups with 2 springs that make contact with the NRU power pins for turning on the NRU prior to offloading or commissioning and applying a charge voltage during offload or commissioning.
- The cup connectors are numbered 1 to 8. Number 8 is always at the end of the panel that has the ethernet ports and power connector.
- Each Data Management cup connector has a TransferJet antenna built into the base, which communicates with the NRU for downloading and commissioning via a proximity EM field.
- The panel has 8 ethernet ports, corresponding to the 8 cup connectors of the panel.



Figure 23

- The 8 ethernet ports connect to an ethernet switch which is used to interconnect other Data Management Panels and the NuScribe computer.
- The power connector is next to the ethernet ports. It is a 4-pin connector. Power input is 12vdc.
- The panels can be wall mounted, rack mounted, or portable case mounted. See the [Portable Case](#) chapter for information on the Portable Data Management Case.

Data Management Panel Use

- To carry out NRU uploading or commissioning operations, the panel must be connected to a NuScribe computer via the ethernet ports and switch.
- The NRUs should be clean prior to loading into the panel. Muddy or wet NRUs need to be cleaned and allowed to dry.
- Once the NRUs are loaded into the Data Management ports, follow the NuScribe manual directions for either upload or commissioning. See NuScribe manual [Rack View section](#).



Figure 24

- The ports should be checked for a buildup of dirt and debris in the bottom of the cups. Too much dirt or debris may keep the NRU from turning on or communicating properly due to the debris obstructing proper seating.
 - Remove power from the panel
 - Use a vacuum, or compressed air, preferably with a line dryer, to blow out the cups.
 - A dry soft brush can be used to loosen debris in the cup prior to blowing it out with compressed air.
 - **No CRC or other aerosol cleaning sprays should be used to clean the cups.**
- The NRUs can be inserted individually. **The nodes do not need to be oriented as the connections are 360°.**
- Insert the NRUs as straight as possible. A straight up and down insertion of the NRUs will avoid damage to the connector cups.



Figure 25

- When initiating an upload or commissioning sequence, if an NRU fails the Connect step with a "Failed to receive NRU status" error, the NRU may not be contacting the springs of the cup.
 - When Charge On is applied to a cup, it will act as a charge panel cup. The NRU will blink a white LED at first, then start blinking a yellow LED indicating charging.
 - The NRU must detect a charge voltage during uploading or commissioning.
 - Moving the NRU slightly may help the NRU contact the springs.
- If the NRU is detected and a serial number is displayed, but keeps failing during further sequence steps intermittently, there may be an issue with TransferJet alignment.
 - Slightly rotate the NRU either clockwise or counterclockwise, then restart the sequence.
 - Repeat if necessary.
- If an NRU shows a continuous flashing purple LED when in the cup connector, it has lost TransferJet communications during a sequence step.
 - Rotate the NRU slightly in the cup connector and restart the sequence.
 - If you are never able to reestablish communications with the NRU after rotating several times and it has never stopped blinking purple, then -
 - Execute a Charge Off command on that cup connector in the Rack view by right clicking on the NRU and clicking on Charge Off in the popup menu.
 - Execute a Data Off command on that cup connector in the Rack view by right clicking on the NRU and clicking on Data Off in the popup menu.
 - Remove the NRU from the cup connector.
 - Using a NuSite device, connect to the NRU and Shutdown the NRU.
 - Reinsert the NRU in the cup connector and start the sequence over.
- Once upload or commissioning has finished, the NRUs can be removed from the panel.

- ***Do not operate a panel if there is any physical damage to any of the cup connectors, especially involving the springs.***
- ***Do not apply power to a panel that has a damaged/broken power connector.***

PRELIMINARY

Chapter 6 Charge Panel (CP)



USB Charging Panel

Charging Panel Overview

- Each Charge Panel is capable of charging 8 NRU at a time.
- The charging ports are clear hard plastic cups with 2 springs that line up with the NRU contacts for supplying voltage to the NRU internal battery charger.
- There are no charging electronics inside the charging panels, they are simply distribution points. The charge circuitry is contained within the NRU.
- The Panels are supplied by a 12vdc power supply(s).
- Depending on scalability, several panels can be supplied by the same power supply depending on the output capability of the power supply in use.
- At peak charge, a single NRU will draw ~1.2 amps. With 8 NRUs charging a single panel will have a current draw of ~9.6 amps.

Charging Panel Use

- See the [cleaning](#) section for instructions for cleaning the NRUs before charging.
- The NRUs can be charged on the charging panel either individually or by 8 in the NRU Cases as seen below in Figure 26.



Figure 26

- Never use a charging cup that is damaged. Always inspect the charging cups before use.
- When a shutdown NRU is plugged into a charging port, the LEDs will flash white once indicating that the NRU has powered on.
- The NRU LEDs will flash yellow during charging.
- A Green flashing LED color will indicate that the NRU has surpassed ~90% charge and a top up charging level is being applied until 100% is reached.
- When the LEDs turn solid green, the NRU is finished charging. The 3 NRUs in figure 27 below show green LEDs indicating full charge. Once removed from the charging cup, the NRU LEDs will remain green for a short amount of time before turning off.
 - **Note:** NRUs coming off charge are turned on. If the NRUs are going into storage, they will need to be put into Shutdown mode. See NuSite manual [Shutdown/Cannot Shutdown section](#) for directions to put an NRU in Shutdown. Or use NuScribe to run a Shutdown sequence.
 - If there is no LED activity from an NRU on charge, the charging cup should be checked to ensure the springs are good and there is voltage. If the charging cup is good, the NRU should be flagged for repair.
- The charger ports should be monitored for a buildup of dirt and debris in the bottom of the cups. Too much dirt or debris may keep the NRU from charging due to the debris obstructing proper seating.
 - Remove power from the panel
 - Use compressed air, preferably with a line dryer, to blow out the charging panel cups.

- A dry soft brush can be used to loosen debris in the cup prior to blowing it out with compressed air.
- A vacuum cleaner may also be used to clean the cups.
- **No CRC or other aerosol cleaning sprays should be used to clean the charging cups.**
-



Figure 27

Optional TransferJet Charging Panel

Charging Panel Overview

- Charging panel use and layout are exactly the same as the USB model except for the spacing of the charge springs and the color of the cup, which is white, and open-sided on the TransferJet panel.

Chapter 7 Portable Charging Case (PCC)



Portable Charging Case Description

- The Portable Charging Case is capable of charging 24 NRUs at one time.
- The Case is wheeled and has an integrated retractable moving handle, for easy transport.
- The charging case contains 3 panels of 8 charging ports.
 - Each panel is supplied by a separate 12vdc power supply. Total of 3 power supplies.
 - There is enough redundancy in the power supply loads, that 1 power supply can run 2 panels of charging ports. If a power supply goes bad, the corresponding panel can be moved over to a good power supply.
 - Power supplies: 90-264vac, 50/60Hz

- 2 cooling fans keep the power supplies ventilated.



Figure 28

Use of the Portable Charging Case

- See the [cleaning](#) section for instructions for cleaning the NRUs before charging.
- The NRUs can be charged in the portable charging cases either individually as shown in Figure 28 above, or by 8 in the NRU Cases as seen below in Figure 29.



Figure 29

- See the [Charge Panel](#) section for Charge Panel use and precautions.
- Never apply power to a Portable Charging Case if it shows any signs of damage.

- The electrical connector is standard 3 pin AC power connector.



Figure 30

PRELIMINARY

Chapter 8 Portable Data Management Case (PDC)



Portable Data Management Case Description

- The Portable Data Management Case is capable of offloading 8 NRUs and charging 16 NRUs simultaneously.



Figure 31

- The case contains 1 panel of 8 Data Management ports.
 - The panel is supplied by a 12vdc power supply.
 - Power supplies: 90-264vac, 50/60Hz
 - 2 cooling fans keep the power supplies ventilated.
 - The panel has 8 ethernet ports which correspond to the 8 panel cup connectors.
 - The 8 ethernet ports connect to a built in ethernet switch which in turn connects to the external ethernet port of the Portable Case. This is used to connect to the NuScribe computer ethernet network.
 - A clear plexiglass cover allows a view of the LEDs on the built in ethernet switch for connectivity indication.
 - The Data Management ports are hard plastic cups with:
 - 4 springs on the USB model panels. 2 springs are used for turning on and charging the NRU during upload and commissioning, and 2 springs are used for USB data communications during upload and commissioning. or
 - 2 springs on the optional TransferJet panels that are used to contact the NRU MIM for turning on the NRU prior to offloading or programming and providing charge voltage during offloading or programming.
 - On this panel model each Data Management port has a TransferJet antenna built into the base, which communicates with the NRU for offloading and programming.
- The case contains 2 panels of 8 charging ports.
 - Each panel is supplied by a separate 12vdc power supply.
 - There is enough redundancy in the power supply loads, that 1 power supply can run 2 panels of charging ports. If a power supply goes bad, the corresponding panel can be moved over to a good power supply.
 - Power supplies: 90-264vac, 50/60Hz
 - 2 cooling fans keep the power supplies ventilated.
- The charging ports are open-sided hard plastic cups with 2 springs that are used to contact the NRU MIM for supplying voltage to the internal NRU battery charger.

- There are no electronics inside the charging panels, they are simply distribution points.
- When using the USB Data Management Panels, it is possible to change between different configuration options, such as having either 1, 2, or 3 Data Management Panels installed in the portable case.
 - When using the optional TransferJet Data Management Panels it is advisable to only have 1 panel installed per portable case.

Use of the Portable Data Management Case

- Follow the NRU cleaning steps in the [Cleaning](#) section .
- Charging can be carried out in the 2 charging panels as it is with the Portable Charging Case, see the previous chapter for details on charging with the Portable Case.
- To carry out NRU uploading or commissioning operations, the Portable Case must be connected to a NuScribe computer via the external ethernet port seen at the bottom of figure 32 below.



Figure 32

- Once the NRUs are loaded into the offload ports, follow the NuScribe manual directions for either offload or commissioning . See NuScribe manual page 63.
- The charger and offload ports should be monitored for a buildup of dirt and debris in the bottom of the cups. Too much dirt or debris may keep the NRU from turning on or uploading properly due to the debris obstructing proper seating.
 - Remove power from the case
 - Use compressed air, preferably with a line dryer, to blow out the cups.
 - **No CRC or other aerosol cleaning sprays should be used to clean the cups. A dry soft brush can be used to loosen debris in the cup prior to blowing it out with compressed air.**

PRELIMINARY

Chapter 9 Manual Deployment/Retrieval Tools



Deployment Tool

- The manual deployment tool is an easy to use device for creating a custom fitted hole for the NRU-1C node, both M and N series.
- Operates as a slide hammer to solution a hole in the earth.



Figure 33



Figure 34

- The correct PPE should be in use when operating the manual deployment tool. Eye and hand protection are recommended at a minimum. Be aware of finger pinch points on the tool. Back safety should be observed while operating the tool, straight back and feet planted in line with shoulders.
- The N series node with the N series deployment tool is seen in Figure 34 above. The tools are the same except for the ground solutioning bit which is specific for the correct series of node.

- Identify the location for the NRU to be planted, as close to the pre-plot receiver point as possible.
- Kick or scrape any loose dirt or gravel away from the point, this prevents any of that debris from falling back into the hole after removing the deployment tool.
- Place the point of the tool firmly on the ground.
- Grip the slide hammer handles firmly with both hands. Slide the hammer up to a height that is comfortable, then bring it down hard.
 - Caution should be used when sliding the hammer up as the slide hammer can come out of the bottom section of the MDT.



Figure 35

- Care needs to be taken to keep the tool straight up and down to create a hole for the NRU that is as near to vertical as possible.
- Repeat the slide hammer blows until the tool reaches the desired depth.
- For the best NRU depth, the tool should be down, so the ground is level with the bottom of the base collar, or just above it. In loose sandy soil, a deeper depth may be needed to compensate for small cave-in material. Start of job experimentation may be needed to find an optimal depth for the tool.



Figure 36

- To completely bury the NRU, drive down until the top of the bottom collar is level with the ground.
- Once the desired depth is reached with the tool, it needs to be rotated slightly, back and forth 3 or 4 times to consolidate the hole sides. Do this by gripping the 2 handles on the main body of the tool. Rotate while pressing down.



Figure 37

- To draw out the tool, holding the 2 handles of the main body of the tool, pull up slowly while rotating the tool slightly. Care should be taken while drawing the tool up to not dislodge dirt from the sides of the hole.
- Place the NRU in the hole.
 - If too much material has fallen into the hole and prevents the NRU from reaching the desired depth, redo the hole with the tool.
- Step on the top of the NRU to firmly plant it in the hole. The NRU should be solid in the ground and have no room for any movement. An NRU with a good plant cannot be removed by hand

easily. Never stomp on an NRU to plant it as that may result in injury to the foot or leg and possibly damage the NRU.



Figure 38



Figure 39

Retrieval Tools

Surface Retrieval Tool

- The Retrieval Tool is used to safely and effectively remove an NRU from the ground,
- Due to the firmness of the EarthGrip plant, most NRU cannot be removed by hand. The Retrieval Tool does this job.



Figure 40

- The claw grips of the tool are custom shaped to fit onto the NRU between the top hex clamp and the bottom clamp of the NRU, or underneath the bottom clamp, whichever is easier to reach.



Figure 41

- Once the retrieval tool is lodged in the groove of the NRU, the NRU can now be levered out of the ground.



Figure 42

- Never hammer or kick the top of the NRU to try to dislodge it from the ground. This may damage the NRU or cause injury to the individual trying to remove the NRU.
- If an NRU has been planted below the level of the ground, a subsurface retrieval tool with long tines will need to be used. See the next section for information on this tool.
- Never use the retrieval tool as a pickaxe or hammer.

Subsurface Retrieval Tool

- This Retrieval Tool is used to safely and effectively remove an NRU that has been planted with the top even or just below the surface of the ground to hide it from easy view and for surface planted NRU as seen in Figure 43 below



Figure 43

- If an NRU has been planted below ground level, use the foot pedal to push the tool tines down till they contact the NRU stainless steel ring.
- Lever the NRU up till it can be pulled from the ground easily.
- Push on the soil around the hole with your feet to settle the disturbed earth back into the NRU hole.



Figure 44



Figure 45

- Care should be taken when handling this tool as the tine ends are sharp. Never use the tool as a pickaxe or hammer.

PRELIMINARY

Chapter 10 Powered Deployment Tools



Battery Rotary Hammer Drill

- Current model in use is a Makita 36v dual battery XRH07 rotary hammer drill.



Figure 46

- The hammer drill is used in places the manual deployment tool cannot be easily used due to the hardness of the soil or in rock.
- The hammer drill can also be used in conjunction with the manual deployment tool.
 - Drill a pilot hole and then solution the hole with the manual tool.
- Always use the required PPE when using the Powered Deployment Tool.
 - Safety glasses/goggles
 - Hearing protection
 - Gloves
- Never wear loose clothing that can be caught by the drill bit. Long hair should be kept under a cap or secured away from the drill chuck and bit.
- Follow manufacturer instructions for use
- Never operate the drill if it is physically damaged
 - Never use drill batteries that are physically damaged
- Only use Makita batteries and chargers



Figure 47

Rotary Hammer Drill (PDT-H)

- In the case where battery power may not be sufficient, an electric rotary hammer drill can be used.
- The current tested model is the Bosch RH540M.
- A small portable source of AC power would need to be available for each drill.
- Operation would be similar to the battery hammer drill; drill depth should be marked on the bit in use to ensure the correct depth for the M series or N series nodes.



Figure 48

Fuel Powered Rotary Drill (PDT-F)

- For very hard drilling areas such as expanses of solid surface rock, a fuel powered rotary drill can be used with a custom built coring bit.
- Coring a hole in the rock with the custom bit forms a hole that fits the NRU.
- Superior coupling to the cored hole is achieved using the NuSeis RocLoc. This coupling is far superior to a standard geophone with a spike wedged into a drilled hole.



Figure 49



Figure 50

Propane Driven Hammer (PDT-P)

- A vehicle mounted propane driven hammer can be used in areas where the ground is too hard for the use of the Manual Deployment Tool.
- The propane hammer can be mounted on the back of different ATV types or a small pickup depending on the terrain conditions.
- The propane driven hammer uses the same type of earth solutioning bit as the manual deployment tool, M series or N series bit.
- The bit is driven into the ground until the desired depth is reached.
- The bit is retracted, and an NRU planted.



Figure 51



Figure 52

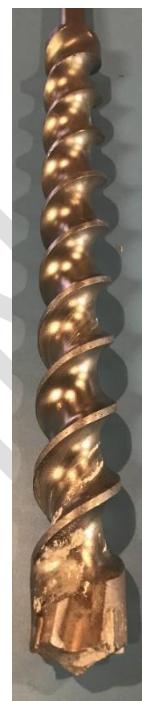
NuSeis Tool Accessories



PRELIMINARY

NuSeis Drill Bits

- The type of drill bit to use to form a hole for the NRU is dependent on the type of ground and surface conditions.
- It may be necessary to do a final solutioning of a drilled hole with a MDT to consolidate the sides of the hole and tamp any loose material that may have fallen into the hole during drill bit removal.
- Depth to be drilled is dependent on the model of NRU in use, M series or N series.
- Can be used with either the PDT-B or PDT-H



- In areas of solid rock, where there is no way to find enough open ground to install an NRU securely, custom rock coring bits are available. Used in conjunction with the PDT-F.



Figure 53

RocLoc

- Used to secure an NRU in a rock cored hole to provide coupling of the NRU to the surrounding rock.
- Adapts the NRU taper to the straight cored hole sides as shown in the 3 figures below.



Figure 54



Figure 55



Figure 56

NRU Threading

- The NRU Threading is an add-on device that adds a screw like threading to an NRU.
- The threads aid in planting the NRU and create more surface area for coupling.
- Using a custom built tool with either the PDT-B, PDT-H or a hand tool, the NRU can be screwed into place. The drill should be capable of normal rotary operation and not be used in hammer mode for this operation.

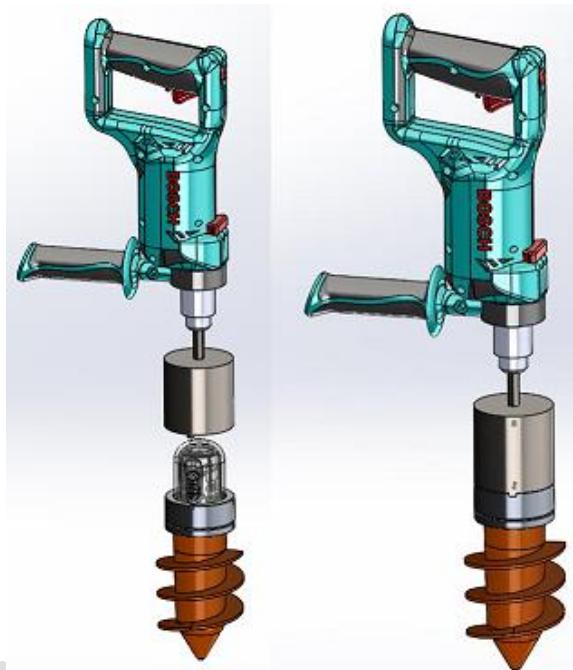


Figure 57

Chapter 11 Automated Deployment System



Automated Deployment System V3

- The Automated Deployment System V3 is meant to automate the deployment of NRUs, effectively speeding up the process and reducing labor needs for laying out the nodes.
- The ADS also adds consistency to planting the NRUs at “true vertical”, and the correct depth.

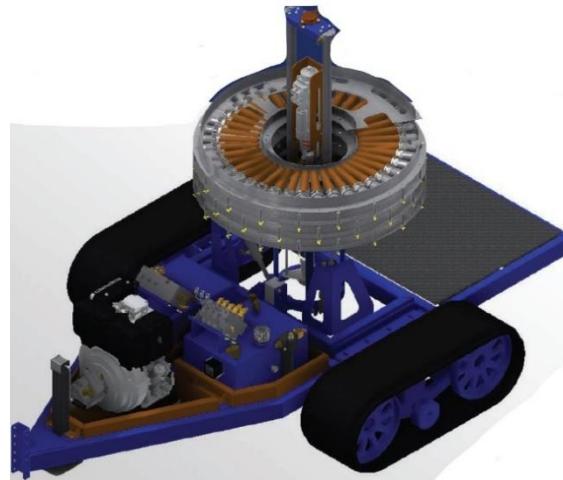


Figure 58

- The system is powered by a Hatz diesel generator, running hydraulic power and electronic actuator.
- Can be towed by most ATVs rated to tow the ADS weight.
- The system is controlled by a pad type touch screen controller, with a sunlight readable screen.
- With the addition of high precision GPS and navigation display, a single operator can drive and control the deployment of NRUs with great accuracy and speed.
- The carousel design allows 160+ nodes to be loaded, ready for deployment.

ADS V3 Specifications

| | |
|------------------------|--|
| Hydraulic Power | Hatz air-cooled diesel engine. (13.7hp @ 3000rpm) |
| | Load-sensing, pressure compensated axial piston pump (18cc/rec, 2500psi max), high pressure filter, proportional control DCV, control manifold, 11.5gal reservoir (approx. 13.5 hours runtime between fueling) |
| Dimensions | 130" long x 80" wide x 62" high |
| Weight | 2300lbs |
| Power of Punch | 62.5 ft-lbs per hammer blow (2550 BPM) with integrated rotation capability |
| Efficiency | System cycle <20 seconds |
| Battery Life | Engine driven alternator producing 14vdc and approximately 16amps @ 3000rpm (engine speed) |
| Standalone | No external power/interface needed to function Towable by any capable UTV |

| | |
|---------------------------------------|---|
| UI | Intuitive, easy to control |
| Ground Pressure (@2750lbs GVW) | 0" compaction 3.895psi ¼" compaction 3.283psi ½" compaction 3.012psi ¾" compaction 2.806psi 1" compaction 2.394psi Also compatible with typical high flotation tires |
| Node Angle | Full range of freedom from true vertical to 15° off axis in 360° orientation |
| Build | High strength, low-alloy power coated tubular frame Spill containment for HPU, fuel reservoir, hydraulic reservoir Ruggedized components with touch-screen operator control |
| NRU Capacity | Capacity for 160+ nodes between reloading |

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