



Nemo-V User Manual

Submersible Iridium Relay / Flasher



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Specifics

This manual version is written with respect to Nemo-V firmware build 8787. If you wish to acquire the latest firmware for your device, contact support@xeostech.com

Version History

Version No.	Date	Description
1.0	Mar 2022	Base document
1.1	Apr 2022	Added Start-up Message, more battery pack details. Change to 0xFF and 0x02 outputs. Added 0x97 message.
1.2	Jun 2022	New current consumption values
1.3	Jul 2022	Added Firmware Update Procedure Added additional payload size details to the \$DA command.

Regular checks for the latest manual are suggested. Be sure to check [Xeos Technologies' manuals page](#) to compare versions and download the latest version.

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Overview

The Nemo-Vehicle (Nemo-V) Submersible Iridium/GNSS Data Relay is specifically designed to act as communication bridge between an autonomous vehicle and its operators.

The Nemo-V makes use of the bi-directional, global, real time Iridium Satellite Short Burst Data (SBD) network in combination with GNSS position location and an ultra-bright LED flasher. The Nemo-V's remote head design allows for better load balancing by separating the locations of the electronics package from its power supply.

Inside the Nemo-V is a 9603 Iridium Satellite Short Burst Data core radio transceiver, a specialized low power Xeos digital controller with GNSS and an ultra-bright LED to aid in recovery.

The Nemo-V is intended for subsurface deployments up to 7500 meters below sea level, with an optional connector upgrade to 11,000 meters. Xeos Technologies Inc. (Xeos) manufactures other specific products for surface applications as well as sub-surface applications at varying depths.

See www.xeostech.com for details or call +1 (902) 444-7650.

Preliminary Setup

Outside Diagram

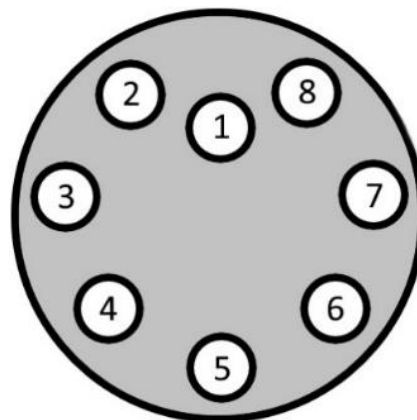
The Nemo-V has several items of note to help identify a specific device. Shown below are those identifiers along with key sections.



1	The LED of the Nemo-V is located here. The titanium sections above and below the glass must be shorted to trigger the water sense
2	The magnet switch for turning the Nemo-V on and off is located directly below the glass
3	The 15-digit IMEI of the Nemo-V's Iridium modem as well as factory serial number.
4	A QR code is available to scan to download the manual on the label
5	The meeting point of the electronics head and battery chamber is torqued and should not be opened. A sealing O-ring is installed here.
6	The bottom female Subconn connector allows for connection to the vehicle and an external battery pack.

Physical Connection

Pin Number	Name
1	GNSS-TXD RS-232
2	TXD RS-232
3	RXD RS-232
4	+V Battery*
5	+V External
6	GNSS-1PPS
7	Ground
8	Ground



Connector: MCBH-8F-TI, External View

***In Single Supply applications, leave +V Battery disconnected.**

Installation

When installing the Nemo-V there are several factors that can influence performance.

- The Nemo-V's head must be pointing directly upward as much as possible.
- Iridium and GNSS performance may suffer if large angles of the horizon are blocked, such as if the Nemo-V is next to a wall.
- Do not use conductive material at the top of the Nemo-V around the glass lens; this will cause the water sensor to fail and could impact Iridium/GNSS performance.

Operational Tips

- Connecting power, or power cycling the device will cause the device to restart from the beginning of its operational cycle.
- The beacon requires a good view of the sky for any test. It is necessary that any tests be done outside of a building, far from potential obstructions.

Setting up an Iridium Account

Nemo-V makes use of the Iridium Satellite Systems' Short Burst Data (SBD) service via the 9603 transceiver. This service is a global (including the Polar Regions), two-way, real-time and email-based data delivery service with a maximum outbound (from beacon) message size of 340 bytes and a maximum inbound (to beacon) message size of 270 bytes.

Nemo-V end users must set up an approved data delivery account with their preferred service provider. This can only be done once Xeos has provided the user with an International Mobile Equipment Identity (**IMEI**) number. For a list of service providers in your area please contact [Iridium](#) for recommendations. Xeos Technologies is also able to provide Iridium SBD data service and accounts. Please contact activations@xeostech.com for more information.

Each IMEI number is capable of being associated with up to five (5) unique destinations (IP addresses or Emails).

Nemo-V makes use of a simple and robust binary email protocol as the default outgoing message format. Any email application can be used to send and receive messages to or from the Nemo-V, however, some messages from the Nemo-V in this format are not human-readable. [XeosOnline](#) is a web-based monitoring system which allows users to view and manage information from the Nemo-V on a mapping system, as well as view the messages in a human-readable format. XeosOnline also allows for the creation of multiple kinds of message forwarders which can forward certain (or all) messages to a group of email addresses in a human-readable form.

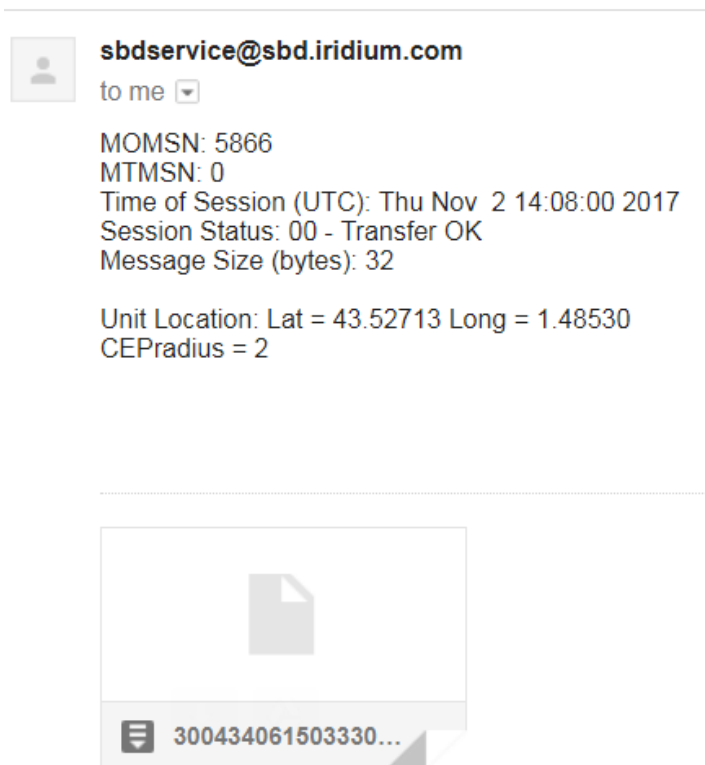
Sending messages and changing configuration can be completed through XeosOnline. See www.xeostech.com or contact Xeos for more information.

Understanding Position Information

There are two types of position information which will be sent via the Iridium Gateway.

Iridium Doppler Position

The Iridium Gateway calculates the Iridium transceivers' position on earth when it receives a transmission, using Doppler technology. As a result, it is often very inaccurate. This location is only visible to users getting emails directly from the Nemo-V, as opposed to emails forwarded by XeosOnline. An example of a "raw" Iridium message via email is below and will always have the IMEI of the device in the subject line, regardless of its name on XeosOnline.



sbdservice@sbd.iridium.com	All messages from Iridium devices come from this address.
MOMSN: 5866	Mobile Originating Message Serial Number; each individual message has its own incrementing serial number. A mobile originating message is one that comes from the Iridium device.
MTMSN: 0	Mobile Terminating Message Serial Number; like the MOMSN, messages to Iridium devices (like commands) also have an incrementing serial number. Since the message in the example is from an Iridium device, the MT number is zero.

Time of Session (UTC)	The time the message arrived at the Iridium Gateway
Session Status	Each message will have a code determined by how well the message was received; codes 00, 01 and 02 are acceptable and will always have their code name (ex. Transfer OK) next to this number.
Message Size (bytes)	The size of the actual message sent by the Iridium device, which is in the attachment in the email.
*Unit Location	The Doppler position of the device as estimated by Iridium's network. It is NOT the position measured by the device.
*CEPradius = 2	The numerical value of how accurate the above position is; with a value of 2, This means that using the Lat/Long that the body has supplied, Iridium is 80% confident (always 80%) that the device sending the message is within a circle, 2 kilometers in radius, with the Lat/Long given as the centre of that circle. The higher the CEPradius value, the larger the circle and therefore the less accurate that position.

*These items can be enabled/disabled by your Iridium provider if desired.

Global Navigation Satellite System (GNSS) Position

Location information generated by the device itself is embedded in the SBD attachment sent via the Iridium Gateway and can only be seen through the XeosOnline system or after parsing that data independently. This position information is accurate to within several feet of the true position.

Timestamp ↕	Latitude	Longitude	Uptime (s) ▲	SNR ↕
Jan 31 2022 06:00:20.001 AM	44.714333	-63.603398	0	44

Nemo-V Systems

The Nemo-V transitions between operating modes based on criteria gained from a single, or in some cases multiple systems. Understanding these systems and what can cause mode changes is necessary to properly use the Nemo-V in the field.

Iridium

The Nemo-V will communicate while on deployment using this system. If the Nemo-V successfully registers with the Iridium Satellite Constellation, Nemo-V will transmit any messages queued to be sent to the user. Once this is finished it will receive any queued messages from the Iridium Gateway and implement them, followed by transmitting the appropriate response. When the Iridium task duration ends, the Iridium modem is turned off.

If messages are queued to be transmitted but are not successfully transmitted, messages remain queued in the volatile memory of the Nemo-V, so long as the device is not reset.

GNSS

The Nemo-V will search for the GNSS satellites and get a location, along with other data for assistance with navigation. The most recent position will be queued for the next Iridium transmission.

The Nemo-V's internal clock will also be set and adjusted based on received GNSS time.

While some NMEA sentences can be [enabled or disabled through commands](#), others are permanently enabled. Below are the available NMEA Strings:

GGA	Fix information from GNSS
GLL	Geographical Position-Latitude/Longitude
GSA	GPS DOP and active satellites
GSV	GNSS Satellites in View - GPS ONLY Message
RMC	Recommended Minimum Specific GNSS Data
VTG	Course over Ground and Ground Speed
ZDA	UTC Date/Time and Local Time Zone Offset

The above sentences may come with Talker IDs of GP (GPS) GL (GLONASS) or GN (Global Navigation/Multi-constellation).

Nemo-V is also able to output a one pulse per second (1-PPS) signal which is enabled after the receiver has achieved a valid position. Using the falling edge of the pulse to indicate the time mark, this time mark is within 1 μ s of epoch and normally within 100 ns. The pulse width of this signal is 250 ms.

The 1-PPS output is disabled if position fix becomes invalid, such as when the Nemo-V Relay is underwater.

The Nemo-V is outfit with a dedicated serial output line, to provide continuous NMEA-0183 updates to a connected device. The port settings of this line are:

Baud Rate	9600
Parity	None
Data Bits	8
Stop Bits	1

Strobe

The strobe of the Nemo-V is present to aid in a possible recovery of the device.

By default, the strobe does not run at any time in Relay Mode, but can be commanded to operate in this mode using the [Strobe Configuration Command \(\\$SL\)](#)

If or when the Nemo-V transitions to Beacon Mode, the strobe is engaged and runs continuously at the rate set by the operator, so long as:

- The light sensor determines the Nemo-V's environment is dark.
- The water sensor shows that the device is surfaced.
- The strobe is not disabled by command overall.

Water Sense

The water sensor continuously monitors for a change in state between surfaced and submerged, with readings taken every 15 seconds. Three consecutive readings of a state different from what is already being utilized will cause a transition in operating mode.

Light Sense

The Nemo-V's light sensor will take a measurement every 5 minutes. If the light level is low enough when compared to the threshold for the device, the strobe will be allowed to flash, provided it is not [disabled by command](#) and the device is not underwater.

Voltage Sense

Readings of the Nemo-V's power supply are taken every two minutes. The Nemo-V reads from the higher voltage from either the V-External (Vehicle) or V-Battery supply lines. When the voltage is found to be lower than the set threshold, the device will transition to an emergency state, which changes the executing state to Beacon Mode.

The level of voltage required to change to an emergency state is configurable with the [Voltage Threshold Command \(\\$VT\)](#).

Using the Magnet Switch

The Nemo-V can be turned on and off via an external magnet near an internal magnetic reed switch, and current on/off state can be identified by observing the strobe brightness.

To turn the Nemo-V on or off, tap the magnet against the Nemo-V at the “Tap Here” label four times. The LED will illuminate with each tap. When enough taps are registered, the Nemo-V will transition power states and display this with a Dim to Bright LED behaviour (if turning on) or a Bright to Dim behaviour (if turning off).

A single tap can be used to determine the current power state of the Nemo-V, as it will display the appropriate brightness for the power state with each tap. The on/off transition can be cancelled after 3 seconds if an insufficient number of taps is received.

Nemo-V Operating Modes

Regardless of the device’s state or positioning, the Nemo-V will **always** begin operation in Relay mode if reset. If the device were in a state where it should operate in one of the other two modes, it will transition to the appropriate mode when the necessary sensor data is received.

Relay Mode

Relay mode is the normal operating status of the Nemo-V and will start in this mode when powered or reset. In Relay mode, the device will continuously run its GNSS to output positional data from its GNSS-RS-232 port and search (as in all other modes) for criteria to transition to one of the other two operating modes via voltage sense, water sense, or command.

The strobe will not run in Relay Mode, unless commanded to do so.

Beacon Mode

The Nemo-V can and will transition to Beacon Mode if specific criteria are met, in an effort to aid in a vehicle’s recovery. In Beacon Mode, the Nemo-V will take periodic measurements of GNSS data, followed by a transmission of that positional data at an interval commanded by the user. The strobe will also immediately be enabled, unless commanded otherwise.

The criteria used to transition into and out of Beacon Mode can be one of the following:

- Sufficient change in voltage beyond the set threshold.
- A command issued either through the RS-232 port, or through Iridium to the device.

Underwater Mode

Underwater Mode is the dormant state of the Nemo-V, to save power when no data can be transmitted or received and is primarily driven by the state of the Water Sensor.

In Underwater Mode, GNSS and Iridium will not be run automatically, except for daily back-up checks. The Strobe is also disabled. Commands can be issued over the RS-232 port as with other modes.

Commanding the Nemo-V

There are 3 ways to communicate with the Nemo-V:

1. Locally via its RS-232 port
2. Over-the-air with XeosOnline
3. Over-the-air with Email SBD messages

To receive commands from the Iridium network, the device in use must have a clear view of the sky. If the device is unable to communicate with the Iridium network, commands will remain queued for five days before they are automatically deleted.

Sending Commands Using RS-232

The Nemo-V can be directly interfaced with a target system through its RS-232 serial connection. The RS-232 connection has the following requirements for proper communication:

Baud Rate	57600
Parity	None
Data Bits	8
Stop Bits	1

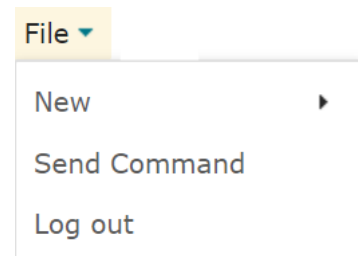
Commands to the Nemo-V all must begin with a dollar sign (\$).

Sending Commands Using XeosOnline

Before using XeosOnline make sure that your account has been set up and your device added to your organization. Contact activations@xeostech.com for more information.

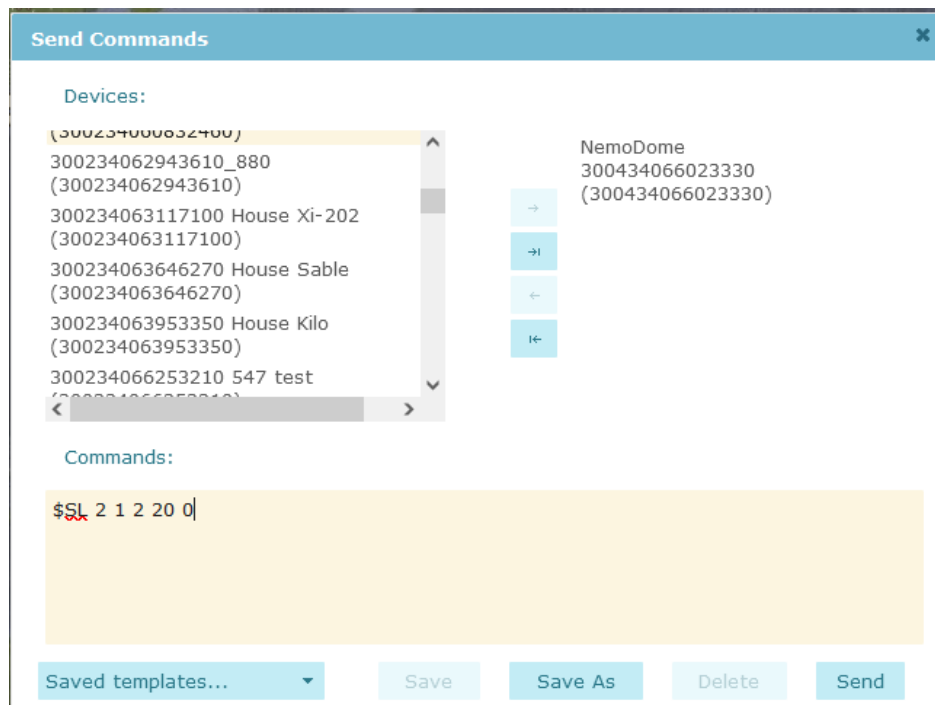
Setting up to Send

- Navigate to the Send Command window.
- From the Home Tab, choose **File > Send Command**
- Select the units you wish to target with commands and move them over to the right-hand target list using the -> button.
- Type your command(s) into the command box and press send.



Remember to include the dollar sign (\$) ahead of each command, and enter each command on a separate line.

Outgoing messages will appear in the Message Log for the commanded device.



Sending Commands via Email

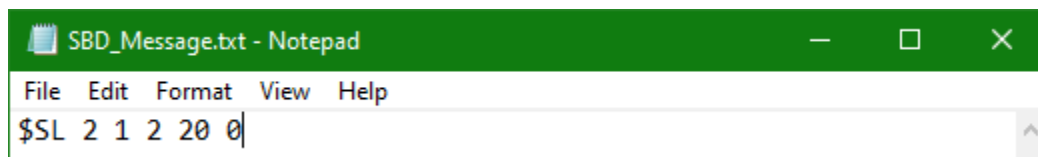
E-mail commands can also be used to communicate with the Nemo-V when it is above water. These commands are sent as email attachments. Commands can configure the Nemo-V remotely in the same way as commands sent by XeosOnline.

Command Format

Command Structure

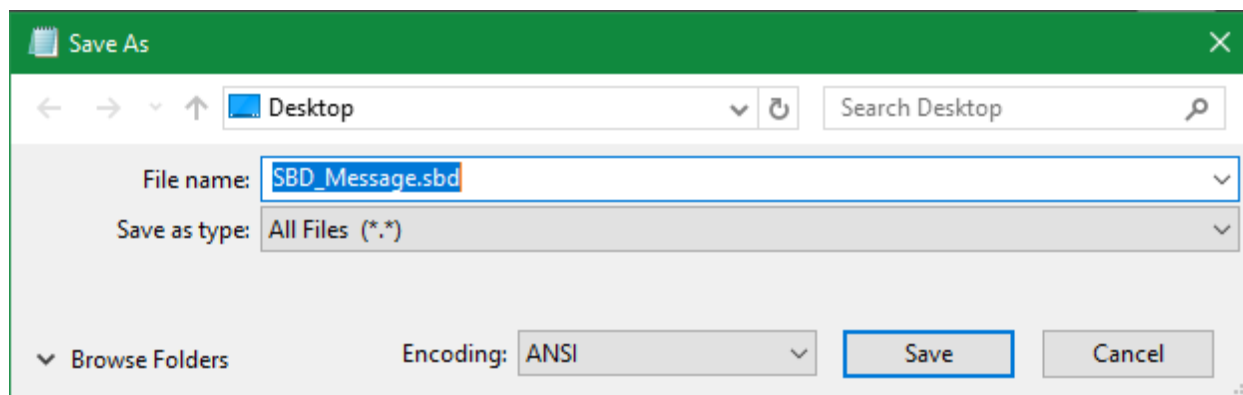
Commands must be structured in the following way:

1. Each command **MUST** have a dollar sign (\$) before each command.
2. A list of commands, one command per line.



Creating the file

Once the commands are written in the text editor (ex. Notepad), save it using the **.sbd** extension. Make sure the **Save as type** option is set to **All Files** to achieve this.



Sending the Command

To send your sbd command, create a new email message with the following fields:

To:	data@sbd.iridium.com
Subject:	Device's IMEI
Body:	Empty
Attachments:	Your .sbd file

A confirmation will be immediately returned from the Iridium Gateway from the address **sbdservice@sbd.iridium.com** indicating that your message is now in the message queue. It will be delivered to the device during the device's next Iridium check.

Commands can be sent from any email address, but responses will be returned **only** to addresses on the unit's forwarding list.

Commands & Local Responses

Below are commands to operate the Nemo-V from any source, as well as their local responses over the RS-232 interface.

For message formats of responses transmitted over Iridium see [Iridium Message Formats](#) later in this document.

Minimum and maximum values to configurations are discussed in the [Settings and Defaults](#) section.

Command Rules

- Commands to the Nemo-V all must begin with a dollar sign (\$).
- Criteria in commands are **space-delimited**.
- Base commands are not case-sensitive.
- If a configuration value is set lower than the allowed minimum, the new value will be the **MINIMUM**.
- If a configuration value is set higher than the allowed maximum, the new value will be the **MAXIMUM**.
- If a configuration value is set to a value of zero, the new value will be the **DEFAULT VALUE** of that setting.
- Configuration settings are saved through resets.

Commands to the Nemo-V also must specify a **source**, specified with a number. These values are as follows:

1	Vehicle
2	Iridium
3	Reserved
4	Diagnostic

Vehicle and Diagnostic utilize the same serial port, however Diagnostic will sometimes give more descriptive responses than Vehicle, useful when testing and understanding some operations. If the source specified is an invalid value, the Nemo-V will send the response over Iridium. This is to allow users to remotely see that erroneous activity is occurring.

The local response from the Nemo-V when the command is incorrectly formatted or has improper arguments is marked with the base command it received followed by an error (ER):

\$DA ER<CR><LF>

To print out a local list of commands and brief descriptions, the Help command can be sent:

\$H<CR><LF>

Data Relay (\$DA)

From Vehicle to Nemo-V

Through the Nemo-V, data can be relayed from the vehicle, to the end user using Iridium. This command is distinctive in that it also must specify a **destination**, separate from the source.

Command	\$DA source destination datatype num_bytes when PAYLOAD <CR><LF>
Response	N/A

source	From where the command is being sent
destination	What system is receiving the data
datatype	Indicates whether the data is to be interpreted as ASCII or Binary. Determines the Iridium message format transmitted. 0 – Binary – Iridium Message Type 0x00 1 – ASCII – Iridium Message Type 0x01
num_bytes	Indicates the number of bytes in the PAYLOAD section
when	Indicates whether the data should be sent immediately, or on the next regularly scheduled Iridium session. 0 – Next Scheduled Iridium session 1 – Send Data Immediately
PAYLOAD	Varying data to be transmitted.
<CR><LF>	Indicates the end of the command.

When using the \$DA Command, it is strongly advised to keep the payload size to a **maximum of 425 bytes** to avoid packet loss. If additional data needs to be sent, a second \$DA command can be sent to the Nemo-V to continue transmissions.

To Vehicle from Iridium

Sending data to the vehicle uses the same command format, with the source specified as Iridium (2) and the destination specified as Vehicle (1).

Command	\$DA source destination datatype num_bytes when PAYLOAD <CR><LF>
source	From where the command is being sent
destination	What system is receiving the data
datatype	Indicates whether the data is to be interpreted as ASCII or Binary. Determines the Iridium message format transmitted. 0 – Binary – Iridium Message Type 0x00 1 – ASCII – Iridium Message Type 0x01
num_bytes	Indicates the number of bytes in the PAYLOAD section
when	Placeholder; use a value of 0 .
PAYLOAD	Varying data to be transmitted.
<CR><LF>	Indicates the end of the command.

When the Nemo-V receives an incoming data relay packet, the following is relayed to the vehicle.

To Vehicle	\$DA datatype num_parts part_num num_bytes PAYLOAD <CR><LF>
datatype	Indicates whether the data is to be interpreted as ASCII or Binary. Determines the Iridium message format transmitted. 0 – Binary – Iridium Message Type 0x00 1 – ASCII – Iridium Message Type 0x01
num_parts	The total number of parts to be received.
part_num	Current part being received.
num_bytes	Indicates the total number of bytes in the PAYLOAD section
PAYLOAD	Varying data being received.
<CR><LF>	Indicates the end of the command.

Request Position (\$PN)

The latest position recorded can be requested by the vehicle at any time.

Command	\$PN source <CR><LF>
Response	\$PN UTC-Date-Time Lat Long Alt <CR><LF>
Example	\$PN 220411140108 4442.8616N 6336.2941W 44.8

- The date-time field specifies from year to second in descending order.
- Latitude and Longitude are displayed in Degrees Decimal Minutes (DDM).

Iridium Mailbox Check Rate (\$IM)

The Nemo-V is configured to transmit positional and payload data via Iridium on a set schedule. The rate of this transmission can be modified as needed.

A value of **-1** in the frequency field can be used to prompt an immediate Iridium session.

Command	\$IM source frequency <CR><LF>
Response (Immediate Check)	\$IM OK <CR><LF>
Response (Rate Change)	\$IM frequency <CR><LF>

source	From where the command is being sent
Frequency	Rate, in minutes, of Iridium transmission.

Strobe Configuration (\$SL)

This setting changes the number of flashes the Nemo-V will fire, and the repetition rate of those flashes.

Command	\$SL source on_off #flashes interval daytime enable <CR><LF>
Response	\$SL on_off #flashes interval daytime enable <CR><LF>

source	From where the command is being sent
on_off	Indicates whether the strobe LED is able to run in Relay Mode. 0 – Off 1 – On
#flashes	Indicates the quantity of flashes per interval
Interval	Indicates how often the strobe will flash (#flashes) in seconds
daytime	Determines whether to allow the Strobe LED to run during the daytime. 0 – Disallow During Daytime (Default) 1 – Allow During Daytime
disable	Indicates whether the strobe can run at all, regardless of mode or location. 0 – Disabled 1 – Enabled

Configure GNSS NMEA Sentences (\$CG)

The Nemo-V is capable of transmitting multiple NMEA-0183 sentences to the vehicle from its dedicated NMEA line. While some sentences are mandatory, others can be enabled (1) and disabled (0) as desired. One command handles all available sentences.

Since GGA and RMC cannot be disabled, they are not included in the command.

Command	\$CG source GLL GSA GSV VTG ZDA <CR><LF>
Response	\$CG GLL GSA GSV VTG ZDA <CR><LF>

Example

In the following example, GSA, VTG and ZDA are disabled.

\$CG **1** **0** **1** **0** **0**<CR><LF>

The device will respond with the same values on success.

Beacon Mode Start/Stop (\$BM)

While Beacon Mode can be entered due to sensor information, it can also be available by command for any purpose, and disabled if desired. The command also specifies how often the device should both collect a position, and transmit that position while in Beacon Mode.

Tip: If commanding the Nemo-V to exit Beacon Mode and the Beacon Mode interval is irrelevant, use a value of 0 for interval. This will restore the timing of Beacon Mode to default (1 Hour).

Command	\$BM source on_off interval <CR><LF>
Response	\$BM on_off interval <CR><LF>

source	From where the command is being sent
on_off	Indicates whether to turn Beacon Mode on or off. 0 – Beacon Mode Disabled 1 – Beacon Mode Enabled
interval	Indicates how often GNSS positioning is acquired and transmitted over Iridium during Beacon Mode, in minutes

GNSS Timing Configuration, Relay Mode (\$GT)

In Relay Mode, GNSS positioning can be set to operate for a set period of time to save power. Both the interval of operation, as well as the duration are configurable.

Since the default GNSS operation in Relay Mode is full-time, setting a value of 0 for both interval and duration restores this setting.

Command	\$GT source interval duration <CR><LF>
Response	\$GT interval duration <CR><LF>

source	From where the command is being sent
interval	How often the GNSS task runs (minutes)
duration	How long the GNSS task runs (minutes)

Voltage Threshold (\$VT)

Sets the Voltage limit the Nemo-V has to read to cause the device to enter an emergency state, in Volts.

Tip: If the voltage threshold is irrelevant to the application, set the value to the minimum to prevent an emergency state.

Command	\$VT source threshold <CR><LF>
Response	\$VT threshold <CR><LF>

System Info (\$SI)

A command to acquire basic production information from the device.

Command	\$SI source <CR><LF>
Response	\$SI ser_num fw_ver <CR><LF>

ser_num	Production serial number of the Nemo-V
fw_ver	Firmware revision number of the Nemo-V

System Status (\$SS)

A command to acquire basic production information from the device.

Command	\$SS source <CR><LF>
Response	\$SS voltage surf_sub mode emerg gnss_state IrdFreq <CR><LF>

voltage	The latest voltage reading taken by the Nemo-V.
surf_sub	Indicates if the Nemo-V believes itself to be in a surfaced or submerged state. 0 – Surfaced 1 – Submerged
mode	Indicates if the Nemo-V is in Relay or Beacon Mode Relay – 0 Beacon – 1
emerg	Shows if the Nemo-V is in an emergency state. No – 0 Yes – 1
gnss_state	Checks if the GNSS module is currently on Off – 0 On – 1
IrdFreq	Transmission rate of the Iridium modem, in minutes

Hello Check (\$HC)

The Hello Check command can be sent to the Nemo-V to determine if communication with the vehicle or other port is operational.

Command	\$HC source <CR><LF>
Response	\$HC OK <CR><LF>

Surfacing Check (\$SF)

The Surfacing Check command can be utilized by the vehicle to give the Nemo-V a head start in acquiring a position once at the surface, as opposed to waiting for a surfacing event to be detected by the water sensor.

This command should be sent to the Nemo-V when surfacing is expected within the next 60 seconds.

Command	\$SF source <CR><LF>
Response	\$SF OK <CR><LF>

Reset Device (\$RS)

This command is for a soft reset of the Nemo-V. Settings are retained through this resetting process.

Command	\$RS source <CR><LF>
Response	\$RS OK <CR><LF>

Factory Defaults (\$FD)

This command is to set all configuration values back to their original state. It does **not** reset the device.

Command	\$FD source <CR><LF>
Response	\$FD OK <CR><LF>

Power Up/Down Nemo-V (\$PS)

This command sets the Nemo-V to an on or off power state. No tasks will be completed when the device is in the off state.

Command	\$PS source on_off <CR><LF>
Response	\$PS OK <CR><LF>

on_off	Command the device to power on or off. 0 - Off 1 - On
--------	---

Settings and Defaults

Below are the default values, as well as the minimum and maximum values for configuration.

- If a configuration value is set lower than the allowed minimum, the new value will be the **MINIMUM**.
- If a configuration value is set higher than the allowed maximum, the new value will be the **MAXIMUM**.
- If a configuration value is set to a value of zero, the new value will be the **DEFAULT VALUE** of that setting.

Relay Mode

Setting	Default	Min	Max
NMEA Sentences Enabled	GGA, GSA, GSV, RMC	GGA, RMC	GGA, GLL, GSA, GSV, RMC, VTG, ZDA, GNS
Iridium Transmission Interval	1 Day (1440 Min)	5 Min	2 Days (2880 Min)
GNSS Position Interval	Continuous (1 Second)	5 Min	2 Days (2880 Min)
Strobe Enable	0 (Disabled)	0 (Disabled)	1 (Enabled)

Beacon Mode

Setting	Default	Min	Max
Iridium Transmission Interval	1 Hour (60 Min)	5 Min	2 Days (2880 Min)
GNSS Position Interval	1 Hour (60 Min)	5 Min	2 Days (2880 Min)
Strobe Enable	1 (Enabled)	0 (Disabled)	1 (Enabled)

Underwater Mode

Characteristics are locked to these settings in Underwater Mode.

Setting	Default
Iridium Transmission Interval	1 Day (1440 Min)
Iridium Task Duration	120 Seconds
GNSS Position Interval	1 Day (1440 Min)
GNSS Task Duration	60 Seconds
Strobe Enable	0 (Disabled)

Miscellaneous Settings

Setting	Default	Min	Max
Strobe Interval	15 Seconds	1 Second	300 Seconds (5 Min)
Strobe Qty	3	1	4
Voltage Alarm Threshold	11.0V	7.0V	24.0V
Voltage Sense Interval	120 Seconds	N/A	N/A
Water Sense Interval	15 Seconds	N/A	N/A
Light Sense Interval	300 Seconds	N/A	N/A

Iridium Message Formats

There are several messages sent from the Nemo-V, depending on setup and conditions. Below are examples of the most common Mobile Originating messages.

If XeosOnline is utilized for viewing data, all messages stated below are parsed for readability. For those not using XeosOnline, the below formats can be used for integration.

For the commands to prompt these messages, see the [Commands](#) section.

Iridium Header

All Nemo-V messages use the following header for parsing purposes, the format of which is below.

Item	Bytes	Description
Start Byte	1	Value is always 0xF1 in the Nemo-V
Message Type	1	Indicates the command or message sent/responded to.
System Voltage	2	Voltage detected at time of transmission, in mV
Time	4	System time in seconds from Jan. 1, 2000
Emergency	1	States if the device is in an emergency state for any reason (1) or not (0)
Payload Length	2	Byte count including Message Type to the end of Payload .
Payload	Varies	The content of the message transmitted

Error (0x97)

If a command received from Iridium has missing or incorrect parameters, a response is sent containing only the message type of the intended command.

Item	Bytes	Description
Intended Message Type	1	The Iridium message type of the intended command

Start-up (0xFE)

In the event of power-up or a reset for any reason, this message is transmitted during the first Iridium session. It can serve as a marker of a reset to the user and does not have a local command equivalent.

Item	Bytes	Description
Serial Number	2	Production serial number
Firmware Revision	4	Firmware revision number installed
Hardware Version	3	Array of Major/Minor/Mods in the Nemo-V
Reset Reason	1	Shows cause of reset, whether intentional or error

Default Position (0xFF)

Likely to be the most commonly transmitted message. This message is utilized when the position is a scheduled session. This is distinct from the 0x02 position format and is the default positioning format of the Nemo-V.

Item	Bytes	Description
Date/Time	4	Timestamp, seconds since Jan. 1 st , 2000, UTC
Latitude	8	Latitude of latest position, multiplied by 10 ⁷
Longitude	8	Longitude of latest position, multiplied by 10 ⁷
Altitude	2	The altitude multiplied by 10.
Max SNR*	1	Maximum Signal-to-Noise Ratio of the position.

* If NMEA sentences that send SNR to the Nemo-V are disabled, the Max SNR value will display as 0xFF in the raw message, or a value of -1 on XeosOnline.

Binary Data Relay (0x00)

Message format used when the **DATA** field is to be understood as Binary.

Item	Bytes	Description
Number of Parts	1	Since relayed data can exceed the max transmission size, number of parts is sent for re-combining.
Part Number	1	Current part being transmitted.
Number of Bytes	2	Number of bytes in the below Data section.
Data	Varies	The information relayed from the Vehicle over Iridium.

ASCII Data Relay (0x01)

Message format used when the **DATA** field is to be understood as ASCII.

Item	Bytes	Description
Number of Parts	1	Since relayed data can exceed the max transmission size, number of parts is sent for re-combining.
Part Number	1	Current part being transmitted.
Number of Bytes	2	Number of bytes in the below Data section.
Data	Varies	The information relayed from the Vehicle over Iridium.

Position (0x02)

Utilized when the position is requested. This is distinct from the 0xFF position format, which is transmitted without being specifically commanded.

Item	Bytes	Description
Date/Time	4	Timestamp, seconds since Jan. 1 st , 2000, UTC
Latitude	8	Latitude of latest position, multiplied by 10 ⁷
Longitude	8	Longitude of latest position, multiplied by 10 ⁷
Altitude	2	The altitude multiplied by 10.

Mailbox Check (0x03)

Item	Bytes	Description
Frequency	2	Value of Iridium check frequency in Relay Mode, in minutes.

Strobe Configuration (0x04)

Item	Bytes	Description
Number of Flashes	1	Quantity of flashes per interval
Interval	1	Indicates how often the strobe flashes, in seconds.
Daytime	1	Allow/disallow strobing during daytime
Enable/Disable	1	Full enable/disable state of strobe.

GNSS Sentence Configuration (0x06)

Item	Bytes	Description
GLL	1	GLL sentence enabled/disabled
GSA	1	GSA sentence enabled/disabled
GSV	1	GSV sentence enabled/disabled
VTG	1	VTG sentence enabled/disabled
ZDA	1	ZDA sentence enabled/disabled

Beacon Mode GNSS Timing Configuration (0x07)

Item	Bytes	Description
Frequency	1	Value of GNSS check frequency, in minutes.
GNSS Duration	1	Duration of the GNSS check, in minutes

Beacon Mode Configuration (0x08)

Item	Bytes	Description
Beacon Mode State	1	Shows if Beacon Mode is active.
Frequency	2	Value of Iridium check frequency in Beacon Mode, in minutes.

System Information (0x09)

Item	Bytes	Description
Serial Number	2	Production serial number of the Nemo-V
Firmware version	4	Firmware build number of the Nemo-V

System Status (0x0A)

Item	Bytes	Description
Voltage	2	The latest voltage reading taken by the Nemo-V, in mV.
Surfaced/Submerged State	1	Indicates if the Nemo-V believes itself to be in a surfaced or submerged state. 0 – Surfaced 1 – Submerged
Relay/Beacon State	1	Indicates if the Nemo-V is in Relay or Beacon Mode Relay – 0 Beacon – 1
Emergency State	1	Shows if the Nemo-V is in an emergency state. No – 0 Yes – 1
GNSS State	1	Checks if the GNSS module is currently on Off – 0 On – 1
Iridium Frequency	2	Transmission rate of the Iridium modem, in minutes

Hello Check (0x0B)

Item	Bytes	Description
OK	1	Confirmation, shown as 0xFB

Voltage Threshold (0x0E)

Item	Bytes	Description
Voltage Threshold	2	Voltage threshold setting in mV

Other

The Surfacing (\$SF), Reset (\$RS), Factory Defaults (\$FD) and Power State (\$PS) commands do not transmit responses over Iridium.

Maintenance

Battery Pack

The back-up power source for the Nemo-V is its internal battery pack. There are three available enclosure sizes for the Nemo-V:

Long Pack	7 Energizer LR20 D-Cell Alkaline	10.5V
Short Pack	3 Saft LSH20 D-Cell Lithium	10.8V

For Lithium models, only the Saft LSH20 has the ability to source enough current to supply peaks in Iridium transmissions.

Replacing Batteries

The mechanism for installing the batteries is the same regardless of which enclosure is provided. A plastic insert is vacuum-sealed to the full length of the inside of the battery chamber to prevent internal shorting.

To replace the batteries:

- Tip the old batteries out of the enclosure once the end-cap has been unscrewed. Make sure to dispose of them appropriately.
- Slide the first battery into the column, ensuring that the positive (+) terminal faces the SubConn connector of the battery pack.
- Add the remaining batteries in the same orientation.
- Restore the endcap to its place on the device, taking care to inspect the O-ring first.

Connector Grease

The connector for every Nemo-V and battery pack manufactured at Xeos is filled with grease to protect the conductive material. If replenishing this grease, Xeos recommends MOLYKOTE 44 Medium.

O-Rings

The Nemo-V has permanent O-rings installed in the head that are not meant to be replaced. The head of the Nemo-V proper is torqued at the factory to prevent accidental opening.

The O-ring of the battery pack endcap is user-replaceable and should be visually inspected to make sure it is properly seated in its groove. It should also be inspected for visible damage or debris.

If the O-rings pass visual inspection and have been deployed for two months or less, they do not need to be replaced.

If the O-rings fail visual inspection or have been deployed for longer than 2 months, they should be replaced prior to re-deploying the Nemo-V.



Non-remote head Nemo-Vs all employ the same O-ring for all areas: **2-031/N70**

Replacing O-Rings

To replace the O-Ring:

- Remove the old O-ring, and clean all dirt away from the threads and grooves where it was seated using a lint-free cloth, cleaning alcohol, and a soft-brush.
- Apply a thin layer of seal lubricant (**MOLYKOTE 111** from Dow Corning) to the new O-ring.
- Slide the new O-ring down over the threads of the endcap and into the O-ring groove.

It is very important to be aware of where the O-ring is sitting on the end-cap. If the O-ring is not sitting perfectly in its groove, there will not be a perfect seal; this could cause fatal damage to the unit.

Electrical Specifications

Power Supply	
Supply Range	9 – 28 VDC
Battery Supply (Xeos Battery Pack)	Short Pack - Qty 3 Saft LSH-20, D-Cell, 10.8V Nominal Long Pack - Qty 7 Energizer Industrial LR-20, D-Cell, 10.5V Nominal
Battery Capacity	Short Pack – 13 Ah Long Pack – 17.5 Ah

Current Consumption (12VDC)	
GNSS Running	14.7 mA
Iridium Running	61 mA
Iridium Tx (Peak)	1.5 A
Strobe Flash	160 mA
Idle	4.7 mA
Device Off	4.6 mA

Only the Saft LSH20 has the ability to source enough current to supply peaks in Iridium transmissions in Lithium models, and is therefore required in these applications.

Batteries should be removed if the device is entering storage.

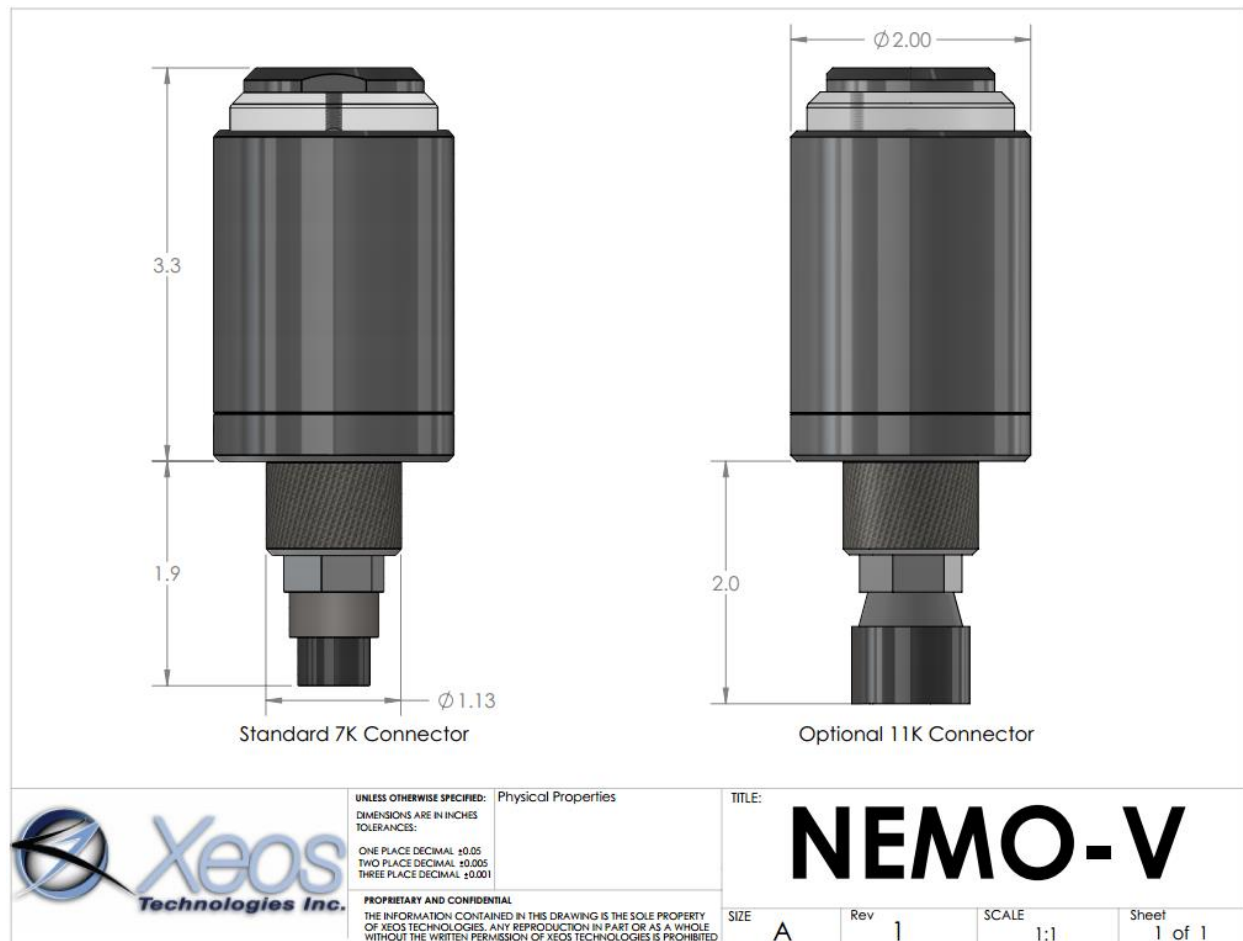
Electronics	
Digital Controller	Xeos Nemo-V
GNSS Receiver	Xeos Technologies 48 channel GNSS (SiRFStarV)
Iridium Transceiver	Iridium 9603
Antenna	Xeos proprietary antenna, designed to withstand high pressure environments

Maintenance Specifications

O-rings	
O-ring Size	2-031/N70
O-ring Lubricant	MOLYKOTE 111

SubConn	
Connector Lubricant	MOLYKOTE 44 Medium

Engineering Diagram



Mechanical Characteristics

Antenna	Titanium ring with non-permeable ceramic antenna component
Flasher Lens	Glass
Housing	Titanium
SubConn	MCBH-8F-TI

Dimensions (7.5k Depth)	Length	Diameter
Head	8.38 cm (3.30 in.)	5.08 cm (2.00 in.)
Connector	4.83 cm (1.90 in.)	2.87 cm (1.13 in.)

Mass (7.5k Depth)	370g - in water 557g - out of water
-------------------	--

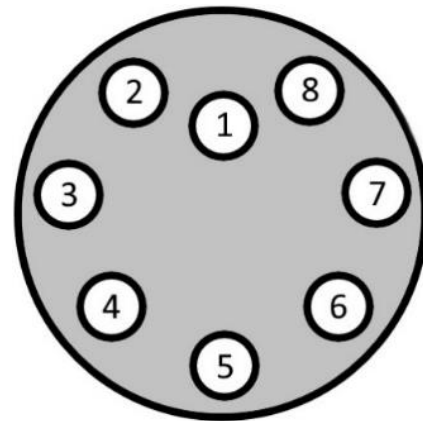
Environmental Characteristics

Operating Temperature	-40° C to +60° C (-40° F to 140° F)
Depth Rating	Submersible to 7500m (24606 ft), standard configuration. Submersible to 11,000m (36089 ft) with 11k connector.

Connector Pinout

Nemo-V

Pin Number	Name
1	GNSS-TXD RS-232
2	TXD RS-232
3	RXD RS-232
4	+V Battery*
5	+V External
6	GNSS-1PPS
7	Ground
8	Ground

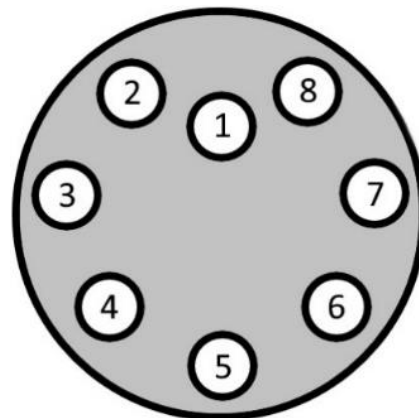


Connector: MCBH-8F-TI, External View

*In Single Supply applications, leave +V Battery disconnected.

Battery Pack

Pin Number	Name
1	N/C
2	N/C
3	N/C
4	+V Battery
5	N/C
6	N/C
7	Ground
8	N/C



Connector: MCBH-8F-TI, External View

Firmware Update Procedure

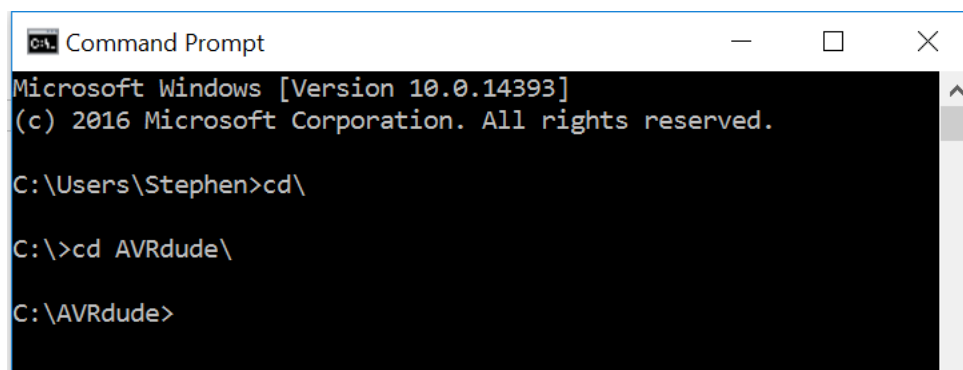
As requirements change and improvements are made, firmware updates will be made available to users through firmware.xeostech.com.

Requirements

- Use of a computer running some version of Windows OS
- USB to Serial cable
- Nemo-V firmware package
- Nemo-V Breakout Cable
- DC Power supply (12V Nominal)

Loading Firmware into the Nemo-V

- 1) Connect the Nemo-V to your PC via the Nemo-V Breakout cable. Do not power at this time.
- 2) Take note of the COM port number in **Control Panel → Device Manager**
- 3) Press **Windows Key + R** to open the run window.
- 4) Type **cmd** and press enter to open a command prompt.
- 5) Create a new folder called **AVRdude** on your computer.
- 6) Extract the contents of the Apollo Relay firmware package containing the firmware update to the new **AVRdude** folder. There should be 4 items in this new AVRdude folder:
 - AVRdude.exe
 - AVRdude.conf
 - Firmware .cmd file
 - Firmware .hex file
- 7) Place the **AVRdude** folder in the **C Drive**.
- 8) Open Command Prompt.
- 9) Type in **cd**, and press **Enter** to bring you to the line **C:\>**
- 10) Next, type in **cd AVRdude** to direct command prompt to the AVRdude folder in the C drive that has just been created. The next line will read **C:\AVRdude>**



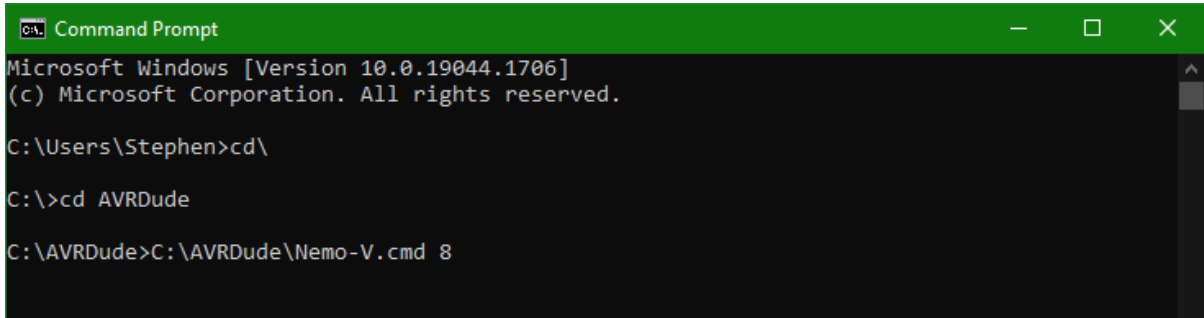
```
C:\> Command Prompt
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.

C:\Users\Stephen>cd\

C:\>cd AVRdude\

C:\AVRdude>
```

- 11) **Drag and drop the .cmd file** from **AVRdude** folder into **command prompt**. Then type in the COM port number previously noted (in this case, **8**), and press **Enter**.



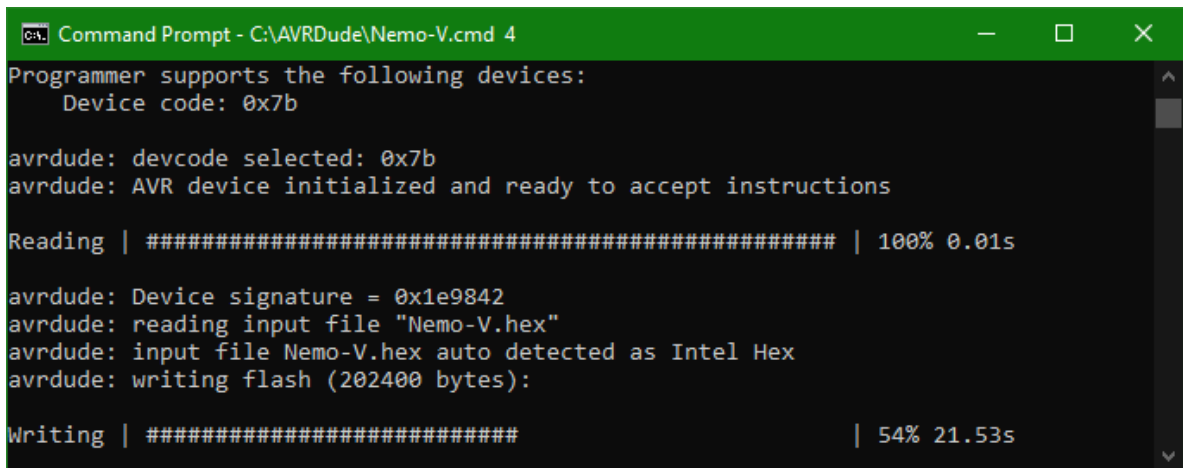
```
Command Prompt
Microsoft Windows [Version 10.0.19044.1706]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Stephen>cd\

C:\>cd AVRdude

C:\AVRdude>C:\AVRdude\Nemo-V.cmd 8
```

- 12) Immediately power the device after starting the AVRdude process. The firmware will begin updating right away. The update process takes approximately 90 seconds. If the window closes immediately upon executing the file, the firmware update has failed. If the AVRdude program does not acknowledge the Nemo-V, simply retry this step, but power cycle each time.



```
Command Prompt - C:\AVRdude\Nemo-V.cmd 4
Programmer supports the following devices:
  Device code: 0x7b

avrdude: devcode selected: 0x7b
avrdude: AVR device initialized and ready to accept instructions

Reading | ##### | 100% 0.01s

avrdude: Device signature = 0x1e9842
avrdude: reading input file "Nemo-V.hex"
avrdude: input file Nemo-V.hex auto detected as Intel Hex
avrdude: writing flash (202400 bytes):

Writing | ##### | 54% 21.53s
```

- 13) The Nemo-V update progress will be shown in the command prompt window. When it has completed successfully it will say: **"avr dude done. Thank You."**

Warranty, Support and Limited Liability

Xeos Technologies Inc. warrants the Nemo-V to be free of defects in material or manufacturing for a period of one year following delivery. Liability is limited to repair or replacement of the defective part and will be done free of charge.

LIMITED WARRANTY: Xeos Technologies Inc. warrants that the product will perform substantially in accordance with the accompanying written materials for a period of one year from the date of receipt.

CUSTOMER REMEDIES: Xeos Technologies Inc. entire liability and your exclusive remedy shall be at Xeos Technologies Inc. option, either (a) return of the price paid or (b) repair or replacement of the product that does not meet Xeos Technologies Inc. Limited Warranty and that is returned to Xeos Technologies Inc. with a copy of your receipt. This Limited Warranty is void if failure of the product has resulted from accident, abuse, or misapplication. Any replacement product will be warranted for the remainder of the original warranty period or ninety (90) days, whichever is longer.

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