ND2310D

10 Channel Distribution Amplifier w/SNMP
Supports: Sine, Square and PPS

Table of Contents

Safety

This product has been designed and manufactured to recognized safety standards and rules. The product is a sophisticated electronic instrument that should be installed and operated by highly trained professionals.

Installation of this equipment should comply with all local electrical codes.

Utilization of this equipment in a manner inconsistent with the operating instructions can be dangerous.

DANGER

There are no user serviceable parts within the unit. Removal of the cover to access interior parts will expose the user to dangerous voltages.

DANGER

The unit may be powered from more than one power source. Care must be taken to be certain all power sources are removed before installation or during removal of the equipment.

DANGER

The unit must be operated with a secure earth ground to the chassis. The electrical path for earth ground is through the power connector. The power switching device that controls power to the equipment must never interrupt the chassis ground connection.

The equipment contains complex electronic components that can be damaged by electrostatic discharge. Observe all recognized standards for the handling of complex electronic devices to avoid high voltage discharge to the equipment. Be certain the equipment chassis and operator are at equipotential before handling the equipment.

Mounting

The equipment is meant to operate in a horizontal - top up configuration.

The equipment is designed to be mounted into a 19 inch standard NEMA cabinet. The unit occupies a single “1RU”. Mounting spaces above and below the equipment may be used as required.

Please observe the operating temperature range for the equipment. If mounted into a closed rack, be certain that the total heat load in the cabinet does not result in an interior operating temperature that exceeds the equipment maximum rated temperature.

If cooling must be used, care should be given to prevent cooling mechanical vibration from the coupling into the equipment. Mechanical shock and vibration may introduce noise into the electronic signals inside the equipment that may degrade the performance of the equipment.

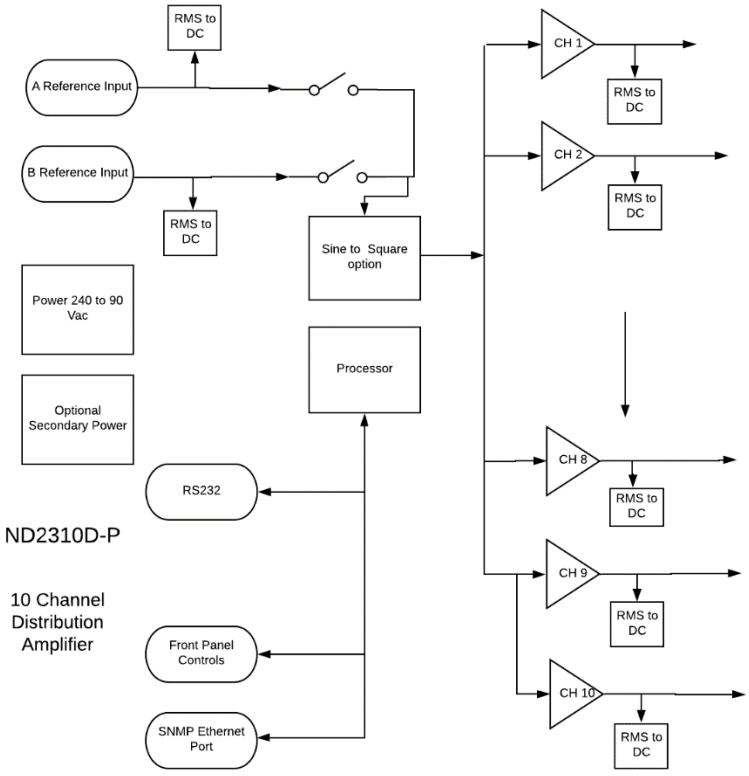
For applications where there is significant shock and vibration, Novus offers equipment with interior mechanical design features to minimize the effects of vibration and shock on the equipment performance.

Summary

The ND2310D is a ten-channel wide bandwidth distribution amplifier. While primarily used for 10 MHz reference distribution, it has a functional bandwidth from DC to 12 MHz but is filtered for the lowest phase noise at 10MHz. For applications other than 10 MHz the unit must be factory configured.

The platform is also available for pulse distribution. PPS or 10 MHz Square wave at either 3.3 or 5 Vdc levels. The pulse and sine versions are not interchangeable.

The sine linear amplifiers are low phase noise design to preserve the integrity of the reference signal. All outputs are transient, and fault protected. The unit is set up with ten outputs and dual inputs A and B. Gain is factory set for 0 dB.



The amplifier can also be optionally redundantly powered. The redundancy feature adds a second power supply which may be AC or DC. The dual input design monitors the input signals and selects the active signal or the prioritized signal. Each output channel is monitored against a defined set of thresholds. If a fault is detected, monitoring will report the fault serially,

The unit features extensive reporting via the rear panel RS232 port - equipment status, output voltage on each channel and redundancy status. By being able to monitor the output voltage, the user can detect cabling issues that cause an impedance change and replace cabling before it completely fails. Reporting is also easily accessible via the front panel display.

SNMP v02 is also available for remote monitoring and control. Appendix D details the capability and features.

Nominal power is global AC power, but a DC power option can be ordered that act as the back-up power supply. Nominally 24 Vdc, this port is used for power when AC power fails. Switching between power sources is automatic and there is no transient power outage at the equipment level. The primary power supply is followed by low noise linear converter assemblies. DC power in the range of -60Vdc to +60 Vdc can be accommodated in three unique ranges.

Controls and Indicators – Front Panel

This section describes the functionality of the front panel controls and indicators. Two buttons above the status LEDs provide navigation through the menus.

A single navigation paddle above the status LEDs provides navigation through the menus. In general, pressing the navigation paddle UP or DOWN advances through the menu layers by function. Pressing the navigation paddle LEFT or RIGHT accesses further functionality within each menu layer.

Channel Status

The channel status can be determined by reading the actual RMS value on the output of each stage. This is compared to a threshold limit that is set by the user as a percentage variation from a saved value. The default variation value is set at ±65% percent from the current state of the amplifier and is user-programmable in 5% increments from ±10% to ±60%.

For pulsed applications, the reported amplitude is the logic level one amplitude.

The range of acceptable channel amplitude can be narrowed around a connected balanced line, so that a channel status below the alert threshold indicates a shorted line, while a channel status above the alert threshold window indicates a potential disconnected cable.

The threshold value at which a channel alert is triggered can be programmed on the alert threshold screen or programmed via the RS232 port. Once set, the unit would continue to monitor each channel and a deviation beyond the set limits would be reported as a failure on the front panel and via RS232.

The channel status feature can quickly detect a cabling failure. Any change in the load impedance will change the output voltage with respect to the divider formed by the output impedance of the amplifier and the load impedance. Failing cables and connectors can be detected early.

The current threshold limits are displayed in addition to the actual measured value. These values reflect the percentage threshold defined in the alert threshold settings. If the output value is too low to give a valid reading, the display will read “LOW.”

The status is displayed on the front panel and is accessible over the RS232 serial bus via DB9.

Status LEDs

There are TWO status LEDs which provide a quick indication of valid unit operation.

Status LED: The STATUS LED will illuminate flashing RED to indicate an input failure. The STATUS LED will flash red if a power supply failure or communication failure is present. The STATUS LED will ***not*** flash red if any valid input signal is present.

Fault LED: One of the output channels has been faulted.

Input Status

The status of either input (A or B) for both input types can be monitored from the input status screen. The input values a displayed in Vrms (sine) or Vdc (PPS). When an input is selected, an arrow appears next to the value indicating that the source on that input is relayed to the output channels.

If no input is present, or the input selection priority does not have an input value which is above the input threshold, the alert LED flashes red. The error is also noted in the fifth field of the $GPNVS,6 string, with the following values:

0 = At least one valid input is available and is relayed to the channel outputs.
1 = Input A is selected and is below the input threshold.
2 = Input B is selected and is below the input threshold.

For pulsed applications, the input signal can be 3.3 or 5 Volt CMOS. The input impedance is 1000 Ohms.

For details on the status strings, see section 5.0 Programmer's Guide.

Input priority can be selected on the Input Priority menu screen, or with the serial command "$INP".

Power Supply Status

The optional power supply status screen provides DC voltage values of the two available power supply sources. The 90-250V AC input is internally connected to an internal 24V AC-DC converter which powers the internal supplies with 24V. This is diode-connected with the external 24V DC input, which can be used in addition to, or in place of, the AC input.

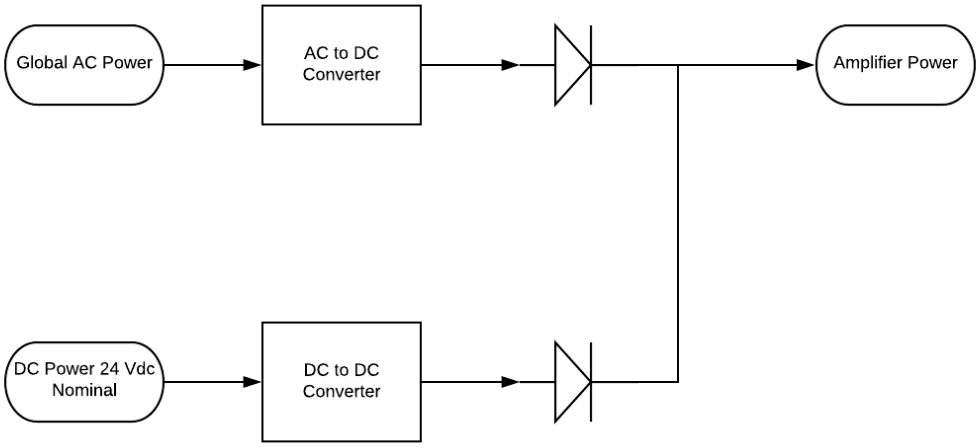
The values of both DC supplies are measured internally to validate connections. The measured values of the AC/DC converter and the DC input are reported in the third and fourth fields of the $GPNVS,2 status string.

For details on the status strings, see section 5.0 Programmer's Guide.

In addition to direct value measurements, each redundant system has a power supply status byte which is reported in the third $GPNVS status string, in the seventh and eighth fields respectively.

Any measurement of the power supply which results in an alert condition will be reported in the power supply status byte.

0x80 = External AC not connected.
0x40 = External DC not connected.



Redundant power supplies operate on either the AC input or DC input, and function independently. All functionality and reporting for an individual power supply and amplifier is independent of its redundant copy.

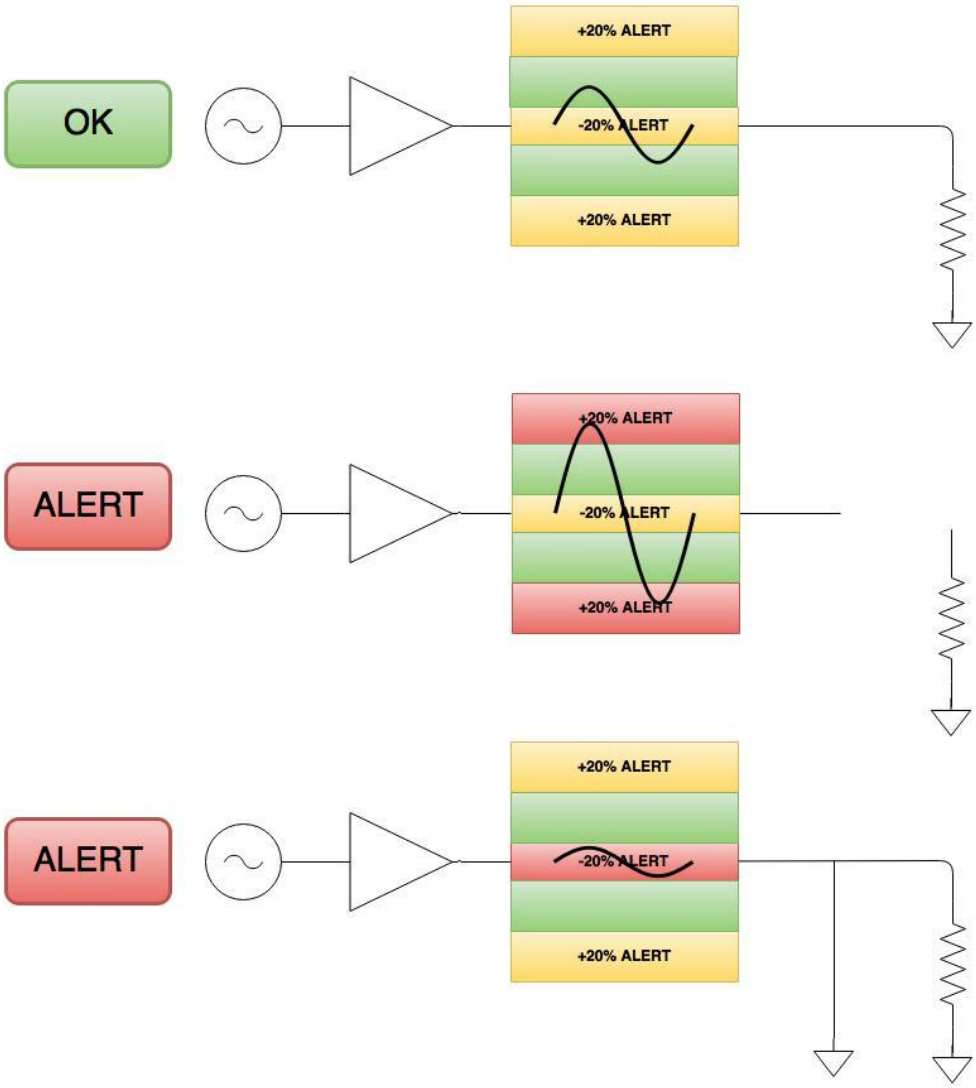
Amplitude Alert Threshold

Each channel has a reference voltage which can be set, all at once, by latching the channel's current value in the latch channel average screen. Each channel's reference voltage can be set individually by writing the value via the rear panel serial port with the $SET command. After saving the current configuration on a channel, any subsequent deviation on that channel which exceeds the alert threshold percentage will trigger an alert.

Steps to ensure correct alert configuration:

1. Connect source input(s) to channel A and/or B.
2. Connect distribution cabling to channels 1 through 10.
3. Set alert threshold to desired range.
4. Save current channel voltages with the latch channel values screen.
5. Save current settings on the save configuration screen.

Note: Alert threshold can be different for Input A and Input B, allowing for variation in the input source. To accommodate both inputs, set alert threshold for Input A and Input B.



The alert threshold can be optimized so that a channel short or an impedance change will cause an alert.

Example:

The output of channel 1 is connected to a high impedance input and reports 1.25Vrms at the output. The output of channel 2 is connected to a 50 Ohm terminated input, and reports 0.90Vrms at the output.

Input A is connected to a ~0.95V 10MHz source.

Alert threshold for input A is set to +/-20%.

The current state is saved in the save configuration screen.

The Channel 1 alert will report when:
- The Channel 1 output is higher than 1.50Vrms
- The Channel 1 output is lower than 1.00Vrms
-

The Channel 2 Alert will report when:
- The Channel 2 output is higher than 1.08Vrms
- The Channel 2 output is lower than 0.72Vrms

Pressing the SELECT button toggles the view between the A and B input alert threshold settings.

To adjust the alert threshold from the front panel, hold the NEXT and SELECT buttons down simultaneously for two seconds. The percentage value will begin flashing. To increase the value, press the SELECT button. To decrease the value, press the NEXT button.

When the desired value is reached, press the NEXT and SELECT button simultaneously to leave the settings mode.

The alert threshold settings can be modified via the RS232 serial port with the $FLTTHRA and $FLTTHRB commands.

For details on the alert threshold, see section 5.0 Programmer's Guide.

Input Threshold

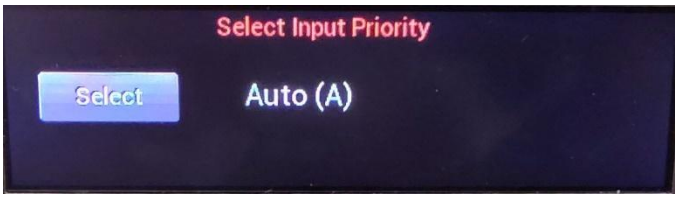
The input threshold screen allows the user to monitor and set the threshold at which the input is regarded as invalid or faulted.

The input threshold value is the absolute voltage (user programmable between 0.1Vrms and 1Vrms) below which the input fault will occur, and the auto input select will consider the signal invalid. The default minimum value is set to 0.20Vrms.

The input threshold settings can be modified via the rear panel serial port with the $INPTHR0 and $INPTHR1 commands.

For details on the input threshold, see section 5.0 Programmer's Guide.

Input Select (when used with Novus select references)



The input select screen allows the user to monitor and select the input priority for inputs A and B. Pressing the SELECT button with advance through the following settings:

- Input A Select
- Input B Select
- Auto Select (Priority A)
- Auto Select (Priority B)

Example: Input select is set to Auto(A). Input A threshold is set to 0.5Vrms. Input B threshold is set to 0.5Vrms.

Input A	***Input B***	***Selection***
0.90V	*0.4V*	***A***
0.90V	*No Connection*	***A***
No Connection	*0.6V*	***B***
0.4V	*0.6V*	***B***
No Connection	*No Connection*	***Last Selected***

The default setting is Auto (A). Input A select and Input B select will select only A or B respectively.

Input select priority can also be programmed via the rear panel serial port with the $INP command:

- $INP=0: Input A Select
- $INP=1: Input B Select
- $INP=2: Auto Select (Priority A)
- $INP=3: Auto Select (Priority B)

The input selection can also be synchronized between amplifier boards. The normal operation of the priority switch between A and B inputs is independent between amplifier boards, meaning the PPS and sine inputs are independently monitored and switched based on the presence of a signal at input.

To synchronize the PPS and Sine priority and selection, the command "$PRLTC=1" sets the priority latch such that, in the event of a failure on input A of either sine or PPS when A is priority, both sine and PPS will switch to B, assuming there are signals on both B inputs. If both A inputs are restored, both sine and PPS will resume sourcing from input A.

The input source can also be selected automatically based on Lock Status or Holdover status, with an optional CAN connector between the ND2310 and NR2110 units supplying input signal.

Switch input on loss of GNSS lock
To select Priority Input on Lock (must have CAN connection to NR2110):

- $PRLK=1 via serial port
- $INP=2 or $INP=3

If the input source indicates loss of GNSS lock, the ND2310 will select the backup signal if the backup unit reports GNSS lock is valid.

Switch input on expiration of holdover
To select Priority Input on holdover (must have CAN connection to NR2110):

- $PRHR=1 via serial port
- $INP=2 or $INP=3

The ND2310 will select the primary input as long as the primary unit reports holdover is valid, regardless of loss of GNSS lock. The holdover period can be adjusted with the $HOP command via the serial port.

- $HOP=<n> (where n is [s], default n = 86400)

For details on the input priority programming, see Programmer's Guide.

Latch Channel Values

The latch channel values screen allows the user to save the current channel output values for use as the reference value for alert settings.

A channel alert is triggered when a channel output voltage exceeds or falls below a percentage of the reference value. This reference value is 1.10Vrms as a default but can be set by the user.

There are two ways to set the reference voltage. The rear panel serial port allows for setting an individual channel's reference voltage with the $SET command. The user can also use the latch channel values to take a snapshot of all current outputs and use these as the reference values.

All channel reference values are with respect to the active Input (A or B). If Input A and input B are both present, this allows for setting references on both inputs to accommodate variation in amplitude between the two inputs.

Save Configuration

The save configuration screen allows the user to save the current settings for alert threshold, input threshold, attenuation, input select, reference voltage and any other settings that have been modified via the rear panel serial port.

The save configuration action is equivalent to the $SAVEFL command on the serial port.

Fault Status

The fault status screen allows a quick overview of any channel faults from the front panel. The total fault count is listed, as well as a visual flashing indication of any channels that are beyond the threshold values.

The system fault screen indicates any failures in the primary system or the redundant backup system. All internal power supplies are monitored (24V, +8V, -8V, 5V) on both the primary and backup systems. A failure on one of these supplies will be indicated with a “PS FAIL” fail warning for either system. A communication failure would be indicated by a “Com FAIL” indicator. Either of these fault statuses will result in the change of the primary to the backup system. The individual statuses of the internal power supplies are also available via the RS232 serial port.

Rear Panel

Channel Outputs – BNC or SMA

There are up to ten outputs across the left-hand side of the rear panel. They are labeled 1 through 10 for both PPS (top) and sine (bottom). Nominally the outputs are 50 Ohm impedance for sine and CMOS levels for PPS.

Power Switch

The rear panel power switch controls AC power input to the unit. If the optional DC input is provided with 24V, or a valid DC supply, the unit will operate. If the unit is powered with the DC Option, the rear panel switch does not remove DC power.

The AC and DC input option provides a redundant and automatic backup source in the case of failure of either input.

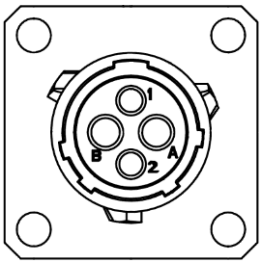
Signal Input A/B

Signal input. Standard impedance is 50 ohms for sine inputs, and 1.2kohm for PPS inputs. Maximum signal input is 1.5 Vrms for sine. PPS input is 5V tolerant. By default, Auto(A) priority is selected, meaning Signal A is considered primary, and B is used if A is measured below the input threshold. The user can change the Signal Input priority via the Front Panel Input Select screen, or via RS232, based on a need for, or the presence of, a particular source.

For pulse inputs, there is signal conditioning that will trigger on a pulse as low as 1 Vdc.

DC Input (Optional)

The optional DC input connector is a 4-pin Amphenol circular connector, P/N RT00102PNH.



Note: Novus PN C0256
This view is the front of the RT00102PNH panel connector.

Pin A is the most positive DC voltage of the DC source. For a 24V source input this would be the positive output from the DC source. (Red 18 AWG)
Pin B is the most negative voltage of the DC source. For a 24V source input this would be the ground or return output from the DC source. (Black 18 AWG)
Pin 1 goes to the Earth ground of the DC source. (Green 22 AWG)
Pin 2 goes to the Earth ground of the DC source. (Green 22 AWG)

Part numbers below are reference for wire harness assembly components. (Not included)

RT06102SNH – mating connector

https://www.amphenol-sine.com/RT06102SNH-Plug-Female-4-Contacts-Contact-Sizes-16-20-13A-5A350V-Shell-Size-10_p_1056.html

RT0L-10CG-S2 – Strain Relief

https://www.amphenol-sine.com/RT0L-10CG-S2-Long-Backshell-straight-Shell-Size-10-Cable-Range-50-85mm_p_1340.html

MS16M23F – Socket Contact for Holes A & B

https://www.amphenol-sine.com/MS16M23F-Socket-Contact-Size-16-Machined-Gold-Flash-Wire-Range-75-15mm%C2%B2-16-18-AWG-Compatible-to-part-RC16M23J-192991-0041_p_921.html

MS20W23F - Socket Contact for Holes 1 & 2

https://www.amphenol-sine.com/_p_941.html

Note: Novus PN C0255
This view is the back of the RT060102SNH mating connector.

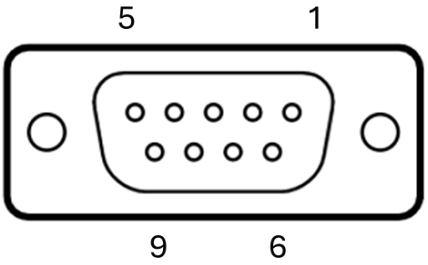
AC Input

The AC input accepts 90-250Vac, 50-60Hz. IEC 320-C14 Compliant.

Serial Port RS232 DB-9

A serial port RS232 DB-9F socket is provided for local setup, and status monitoring. The embedded processor provides status strings, as well as command responses.

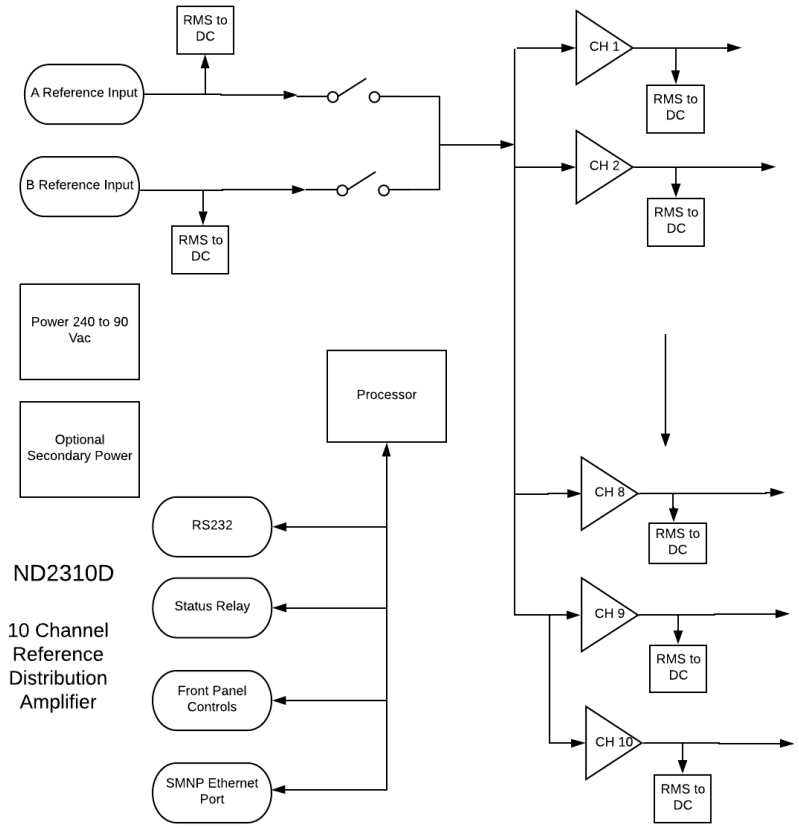
RS232 Serial Port: Rear Panel Pin Connections



Pin	Function	I/O
1	NC	
2	Command Port TX	O
3	Command Port RX	I
4	NC	
5	GND	GND
6	NC	
7	NC	
8	NC	
9	NC	

The default settings for the rear panel RS232 port are 115200 baud, 8 bits, 1 stop bit, no parity.

Functional Description



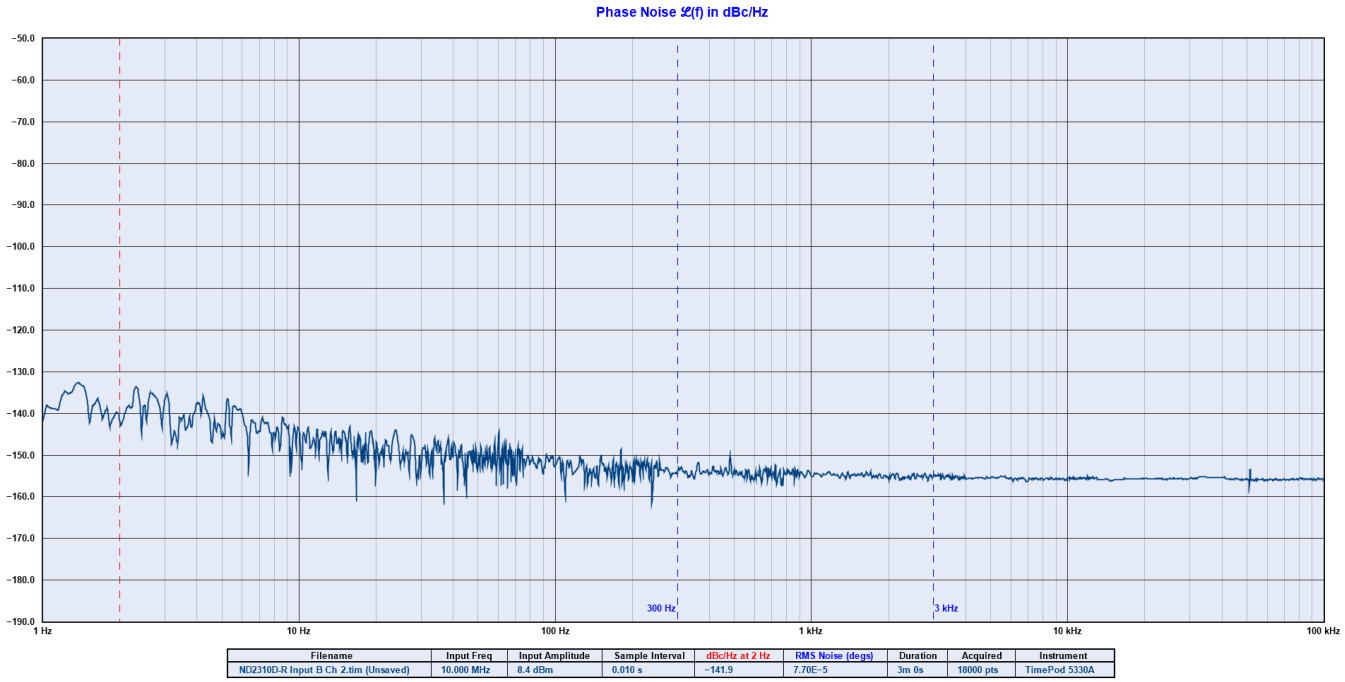
Bandwidth

20 KHz to 10MHz. Gain flatness is ±2dB. The amplifier is available with output drive to DC. Though the unit operates well across wide bandwidth, filtering and design have been optimized to reduce phase noise at 10 MHz.

For pulsed applications, 10 MHz to PPS at CMOS levels into 50 Ohms.

Phase Noise

Low phase noise contribution is achieved through careful PCB design, component selection and minimization of power supply noise. Below is a typical phase noise performance for a 10 MHz reference application:



Outputs

Each output is fault and electrostatic discharge protected. Each output is independent, and any output can be faulted for an indefinite period of time with no permanent damage. Each output is connected to a monitor circuit that detects a local fault on the output. The FAULT status is indicated on the front panel LED. The fault status and the protection on each output facilitates installation to help prevent damage. A channel fault will not activate an “ALERT” state and the status relay will not be opened.

The nominal application is for a 10 MHz sine wave output in the range of 1 Vrms. Square wave output at 3.3 or 5 Vdc or PPS at 3.3 or 5 Vdc is available.

Built-in Test

There are numerous power supplies in the design to meet special needs and noise reduction. All power supply voltages are monitored and can be accessed via RS232. In addition, all current channel statuses, or Vrms values, can be monitored, as well as power supply health.

Power Supplies

The unit is designed to accept power in the range of 90 to 264Vac, 50 to 60 Hz. This allows global application. The design is such that no action need be taken to operate from global power types. This feature avoids

installation damage that occurs in designs that require an input power switch mode be used.

There is an EMI filter between the internal power supply and the available power being used. This filter minimizes the electrical noise from entering the circuitry and negatively impacting noise performance.

Also, in most applications, the equipment that surrounds this unit is sensitive and the filter also reduces noise that could impact the performance of other equipment.

If the optional DC Power Option is installed, the unit can be powered from nominal 24 Vdc. The output of the DC-to-DC converter is effectively diode OR'd with the AC supply and the DC power supply becomes the prime when the AC power fails.

Front Panel USB Serial and SSH Network Commands

The ND2310D front panel USB port is used to connect directly to the System Linux operating system.

ns (Novus System) commands are entered at the system command line prompt with command and flag setting parameters.

admin_user@ND2310D-P:~$ ns -h <cr><lf>

ns Command Line Usage
ns [flags]
ns [command]

Hardware Commands

baud	RS232 rear panel baud rate
cal	calibration factors
flash	onboard flash
input	input a, b channel settings
stat	get $GPNVS status strings

completion	Generate the autocompletion script for the specified shell
conf	A brief description of your command
device	A brief description of your command
disable	A brief description of your command
dump	A brief description of your command
enable	A brief description of your command
get	A brief description of your command
help	Help about any command
ip4set	ip4set ip gw
ntp	A brief description of your command
pps	A brief description of your command
print	A brief description of your command
ptp	A brief description of your command
read	A brief description of your command
run	A brief description of your command
stop	A brief description of your command
write	A brief description of your command

Additional Commands:

access	define network access
date	set system date
help	Help about any command
host	get hostname
login	A brief description of your command
network	configure network parameters
port	ethernet settings
service	manage system services
test	A brief description of your command
time	get system time

Flags:

-h, --help	Display details of ns
-t, --toggle	Help message for toggle
-v, --version	Display version of ns

Use "ns [command] --help" for more information about a command.

nct is a tool for configuring Novus products network specific operations.

nct Command Line Usage:

```
nct [flags]
nct [command]
```

Available Commands:

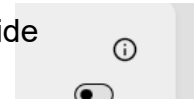
```
completion  Generate the autocompletion script for the specified shell
conf        A brief description of your command
device      A brief description of your command
disable     A brief description of your command
dump        A brief description of your command
enable      A brief description of your command
get         A brief description of your command
help        Help about any command
ip4set      ip4set ip gw
ntp         A brief description of your command
pps         A brief description of your command
print       A brief description of your command
ptp         A brief description of your command
read        A brief description of your command
run         A brief description of your command
stop        A brief description of your command
write       A brief description of your command
```

Flags:

```
-h, --help      help for nct
-t, --toggle    Help message for toggle
-v, --version   version for nct
```

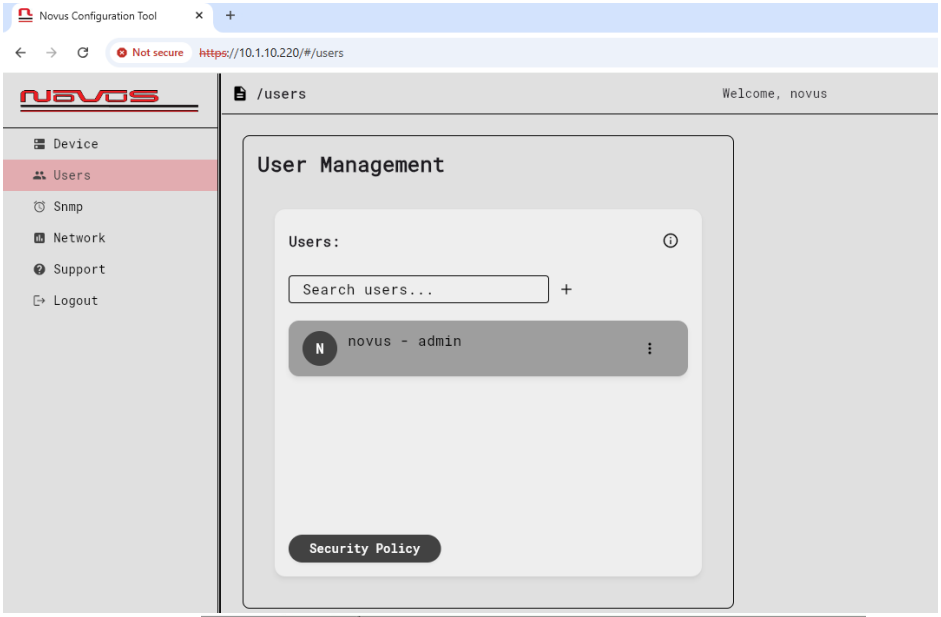
Rear Panel Ethernet Network Interface

The ND2310D Ethernet port is used to connect directly to the web-based user interface. The system includes integrated web pages with secure user access for network system configuration management. The system includes a webpage dashboard with selectable settings for user access, network and SNMP configuration. For all of the settings there is an information button to provide some detail on the use of that setting.



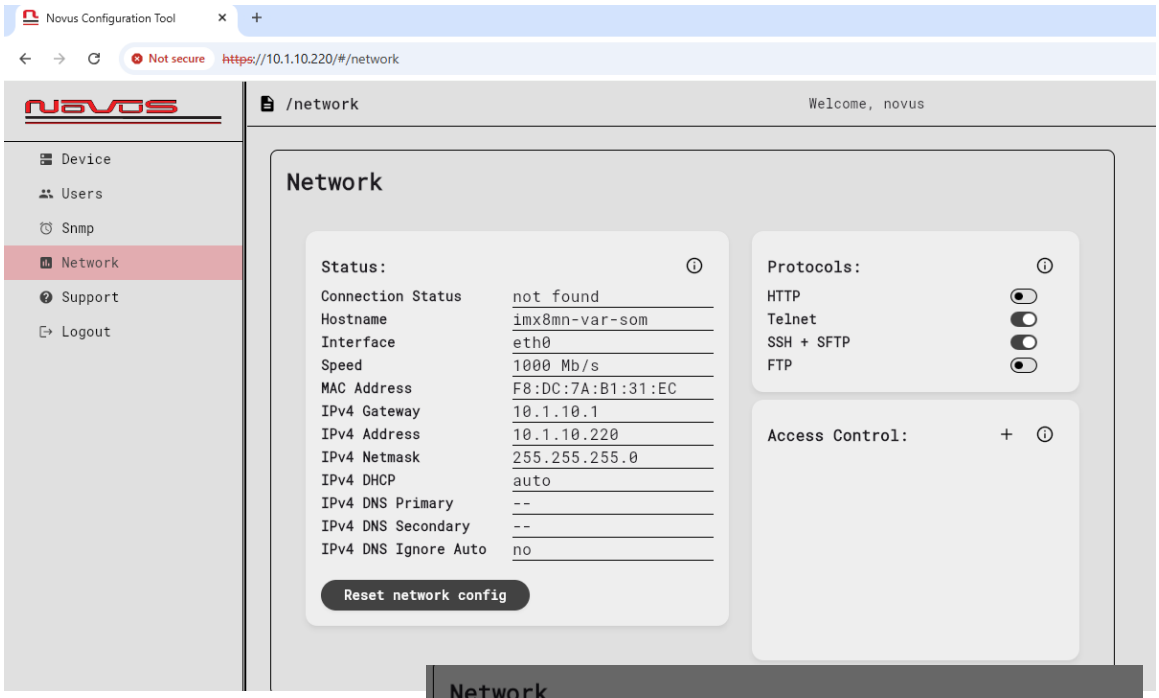
User management

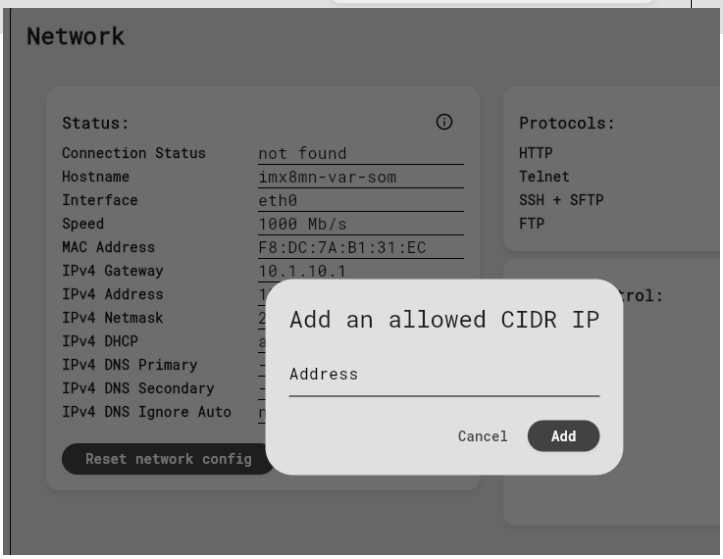
Select the User Management tab to assign users and set access permissions, Change password, and configure password settings and security settings. This page allows administrators to add users, look up existing users and configure the password policy. Some configuration changes will be restricted to users with administrator permissions.



Network configuration

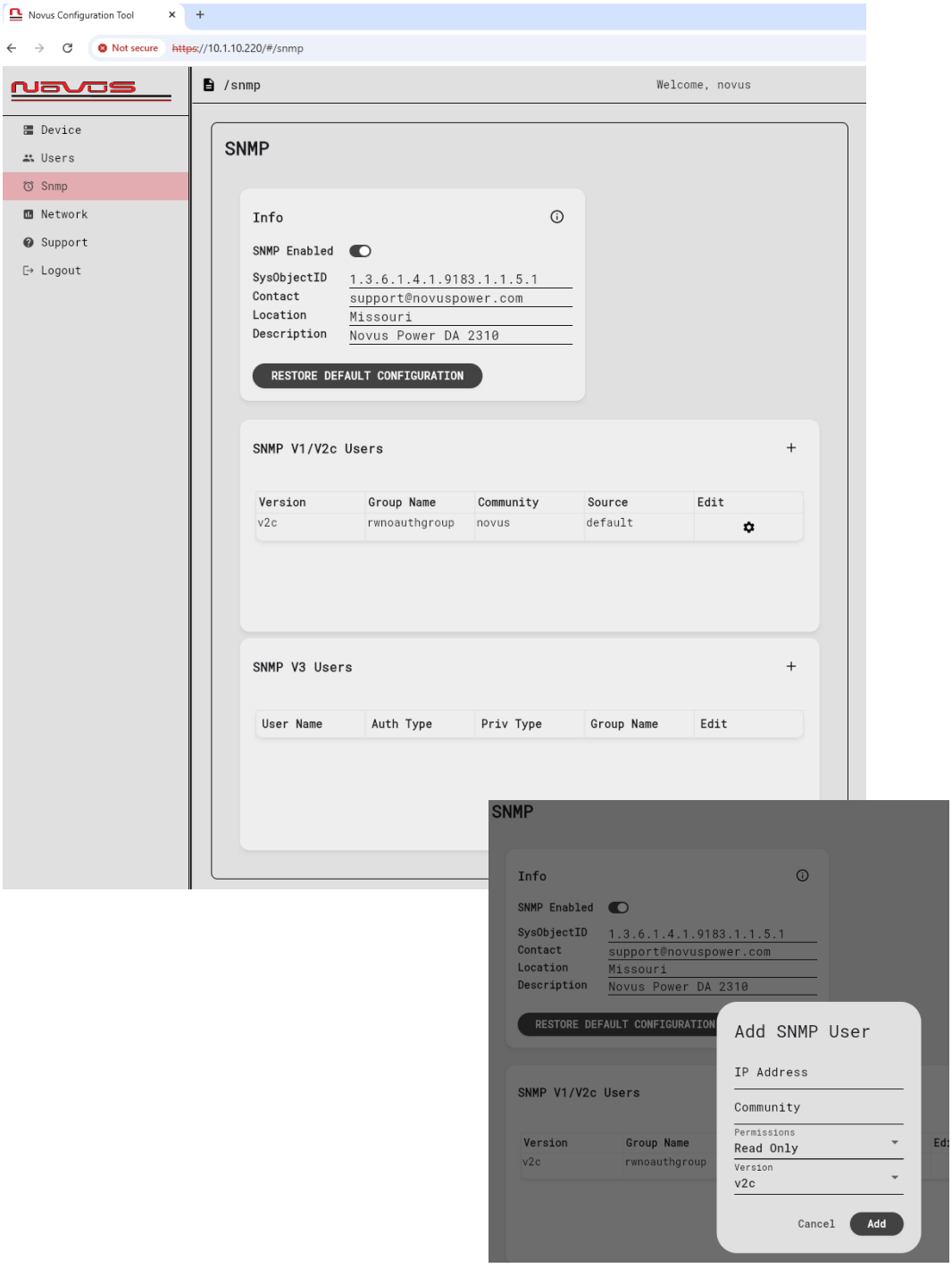
The network configuration page is used to manage network interface settings for IPV4. The Network page includes capability to enable/disable protocols available for user access. The **Access control** form is used to add restrictions to which IP addresses would be authorized to access the webpage system configuration tools.





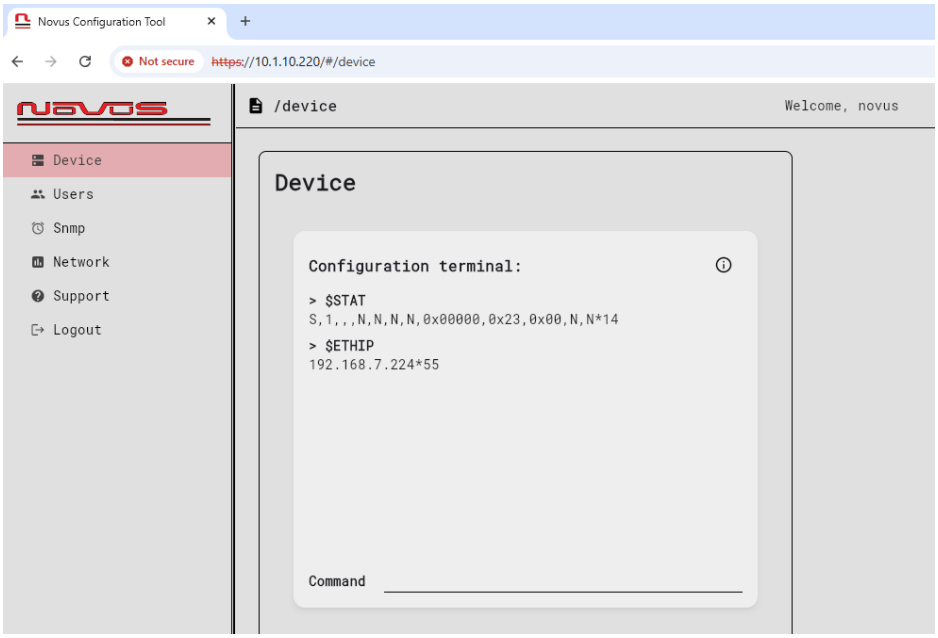
SNMP Configuration

The SNMP page allows adding users, and setting enable/disable access to the SNMP interface.



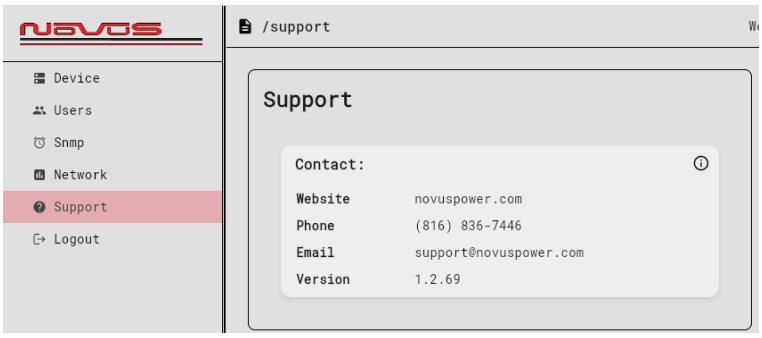
Device Configuration Commands

Device Configuration commands are used to set system configuration and fault parameters to provide specific fault detection levels and query of performance status. The settings can be saved in non-volatile flash memory.
These commands are the same as used from the rear panel serial interface. The description of the usage and settings is documented in the subsequent section ***Rear Panel Serial…*** .

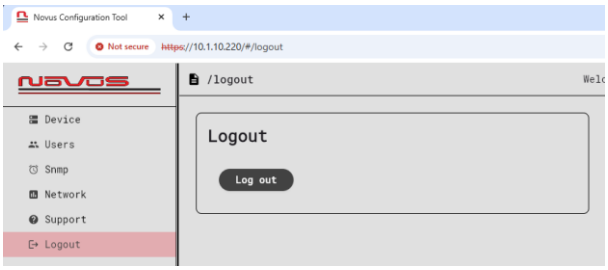


Support

The support page provides information on how to contact Novus. The version number of the software is available here.



Logout
The Logout page is available to exit the configuration session and return to the Login page. Click the **Log out** button to exit the session.



Rear Panel Serial Port RS232 – Configuration Guide

The ND2310D rear panel port is used to set system configuration and fault parameters to provide specific fault detection levels and query of performance status of the system. The settings can be saved in non-volatile flash memory.

If the user makes one or more changes which are intended to be kept between power-off cycles, using the command "$SAVEFL <cr><lf>" will update flash to reflect all current settings.

The following tables show a complete list of input commands and descriptions. In general, a command may be input without "=" or an additional value, and the unit will respond with the current setting's value. If the input is not understood, the microcontroller will return the value "$?*3F<cr><lf>"

NOTE: All commands should be prefixed with "$", and followed by <cr><lf>.

Example: $<*COMMAND*><cr><lf>.

Note: Commands are general purpose and references to channels above the unit channel count are to treated as examples.

Device configuration Rear Panel Serial Commands

Setting	Command	Response	Description
REAR PANEL SERIAL PORT BAUD RATE	$BAUDNV	$BAUDNV=<current Baud Rate>	Query Baud Rate on rear panel RS232. (Default = 115200). Front Panel is 115200 baud.
	$BAUDNV=38400		Assign Baud rate to Rear Panel RS232 port. Default is 115200. Available baudrates are 19200, 38400, 57600, 115200, 230400. Note: Front panel baud rate is set to 115200.
INPUT PRIORITY SELECT	$INP	$INP=<current INPUT priority>	Query or set the Input Priority Setting to A, B, or AUTO (A) or AUTO (B). 0 = Select Input A 1= Select Input B 2 = Auto Select (Prioritize Input A) (Default) 3 = Auto Select (Prioritize Input B)
	$INP=2		
CHANNEL FAULT THRESHOLD FACTOR	$FLTTHRA $FLTTHRB	$FLTTHR<n>=<current Channel Fault Threshold factor (from 0.05 to 0.95)>	Query or set the ratio at which the Channel output monitors report a fault. For example, if the FLTTHRA is set to "0.15", the Channel Fault Word will report an error if the measured value is greater or less than ±15% of its target value, when sourced from Input A. Number format must be in the form <n.nn>
	$FLTTHRA=0.15		
INPUT LOW THRESHOLD VALUE (V)	$INPTHR0 $INPTHR1	$INPTHR<n>=<current Input Threshold (from 0.05V to 1.00V)>	Query or set the absolute voltage at which the Input monitor reports input fault. For example, if the THR is set to "0.3", the Channel Fault Byte will report an error if the measured Vpp is lower than 0.3V. $INPTHR0: Amplifier board 0 (top) $INPTHR1: Amplifier board 1 (bottom)
	$INPTHR0=0.20		
SET INDIVIDUAL CHANNEL REFERENCE VOLTAGE	$SET<nn>=n.nn Examples $SET01=01.00 $SET02=01.00 $SET03=01.00 . . . $SET15=01.00	$SET<nn>=nn.nn	Set or query the Reference Voltage for a particular channel with respect to the active input. Use in combination with the Channel Fault Threshold Factor to define Alert on an individual Channel. Reference Voltages are set with respect to the active input, allowing for variation in amplitude between Input A and Input B. *Example: Set Channel 4 to Alert if it is beyond +/-20% of 0.90Vrms when relayed to Input A:* $SET04=0.90<CR><LF> $FLTTHR=0.20<CR><LF> (To set all channel Reference values to their current average amplitude, use the Latch Average Channel Values command.)

Rear Panel Serial Commands continued…

Setting	Command	Response	Description
CAL FACTORS	$CAL<n>=nn.nn $CAL1=11.10	$CAL<n>=nn.nn	Query or set Cal Factors for specific ADC conversions. See list of Cal Factors numbered for appropriate measurement parameters. These settings should only be changed by an authorized technician.
SAVE ALL CAL FACTORS TO FLASH MEMORY	$SAVECAL	$SAVED CAL. $SAVE CAL FAILED.	This command will translate all Calibration Factors to flash string and write. Data is then read back for verification and result reported. This will update Cal Factors in flash to the current Cal Settings.
SAVE ALL SETTINGS TO FLASH	$SAVEFL	$SAVED	This command saves all user settings to flash.
STATUS OUTPUT	$STAT<n>	<$GPNVS,1….>	Query NVS<n> String. Useful for status output on demand when user does not require regular string output.
	$STAT1		Outputs current $GPNVS,1 string on demand.
	$STAT2	<$GPNVS,2….>	Outputs current $GPNVS,2 string on demand.
	$STAT3	<$GPNVS,3….>	Outputs current $GPNVS,3 string on demand.
RESET ALL TO DEFAULT	$RESETALL	$RESET FLASH VARIABLES.	Resets all user settings to default values and overwrites flash memory with defaults.
INVALID INPUT		$?	Command not recognized.

IP Settings	Command	Response	Description
IP ADDRESS	$ETHIP $ETHIP=n.n.n.n	$ETHIP=192.168.7.200	Set or query IP address buffer to send to onboard Linux SNMP/NTP linux module. Set in conjunction with $ETHMK and $ETHGW.
SUBNET MASK	$ETHMK $ETHMK=n.n.n.n	$ETHMK=255.255.255.0	Set or query Subnet Mask buffer to send to onboard Linux SNMP/NTP linux module. Set in conjunction with $ETHIP and $ETHGW. When all three are set, forward to module with $ETHUP command.
DEFAULT GATEWAY	$ETHGW $ETHGW=n.n.n.n	$ETHGW=192.168.7.254	Set or query Default Gateway buffer to send to onboard Linux SNMP/NTP linux module. Set in conjunction with $ETHIP and $ETHMK. When all three are set, forward to module with $ETHUP command.
UPDATE LINUX SUBMODULE ETHERNET ROUTE	$ETHUP	$ETHUP	After setting IP ADDRESS, SUBNET MASK, and DEFAULT GATEWAY, send the $ETHUP command to update the route table on the Linux SNMP/NTP module. The module will restart, and display the updated IP Address information.

Specifications

Technical Specifications

Linear amplifier bandwidth	5 or 10MHz, 1.2 Vrms max (option to DC available) Bandwidth limited for 10 MHz reference applications.
Impedance	50 Ohm
Channel skewing	< 1 ns (typical < 200 ps).
Latency	< 25 ns
Gain	0 dB
Phase noise	1 Hz -130 dBc/Hz
	10 Hz -140 dBc/Hz
	100 Hz -150 dBc/Hz
	1000Hz -150 dBc/Hz
Pulse	
Levels	Accepts 3.3 or 5 Vdc logic levels.
Input impedance	1 kOhm
Output load	50 Ohm for 3.3 or 5.5 logic levels (factory configurable)
Pulse Frequency	From 1 pps to 10 MHz square
Rise and fall times	< 3 ns
Channel skewing	< 1 ns (typical < 200ps).
Latency	< 25 ns
Channel status, system	channel status, system status - front panel display – serial port
Rear panel connectors	10 output, signal in and system status BNC
Harmonics	< -30db
Remote interface & control	
Protocol	RS232 NMEA-0183
Connector	DB-9
Location	Rear panel
Protocol	Bit plus stop
Standard Baud Rates	Selectable 19200, 38400, 57600 or 115200 bps
Connectivity	Ethernet: 10/100M RJ-45
SNMP	v2, v3
Serial port	RS232
AC input	90 to 250 Vac, 50/60Hz, IEC 320-C14
DC input	24V, 2A (Call for options)

Environmental and Mechanical

Operating temperature	0 to 50°C non-condensing
Storage temperature	-40 to 70°C
Height	1RU (~1.73”)
Width	19.0”
Depth	13.0”
Weight	5.5 lbs.
AC input	90 to 250 Vac, 50/60Hz, less than 10 Watts

Appendix C – $GPNVS Status String Definitions

1.0 The $GPNVS Serial Status String

Novus products provide, in many cases, serial data output from a standard GNSS receiver matching the NMEA 0183 protocol. This is usually a direct connection to the receiver.

In addition to NMEA, Novus Products which provide an additional RS232 serial port for status monitoring, will be set up to meet the following protocols. These are designed to be standardized across different products, and easy to port and use via serial-to-ethernet connections.

1.1 Status String ($GPNVS,1) Fault Bytes

$GPNVS	1	hhmmss	mmddyy	A	A	nn	nn	0x0000	0x00	0x00	n12	n13	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		14

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	1
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	GPS 1 Lock (Valid)	“A” = Valid, “V” = Not Valid, “N” = N/A
6.	GPS 2 Lock (Valid)	“A” = Valid, “V” = Not Valid, “N” = N/A
7.	# of Sats in View (1)	Greater of GPS or GNSS count, “N” = N/A
8.	# of Sats in View (2)	Greater of GPS or GNSS count, “N” = N/A
9.	Channel Fault Byte	0x0000 to 0xFFFF (Hex OR’d value)
10.	Power Supply Fault Byte	0x00 to 0xFF (Hex OR’d value)
11.	Error Message Byte	0x00 to 0xFF (Hex OR’d value)
12.	Antenna 1	“0” = Ok, “1” = Error, “N” = N/A
13.	Antenna 2	“0” = Ok, “1” = Error, “N” = N/A
14.	NMEA Checksum	*XX (xor’d value of bytes between $ and *)

Example:
$GPNVS,1,233518,092516,A,A,10,11,0x0000,0x00,0x00,0,0*23

1.2 Status String ($GPNVS,2) Channel Values 1-8

$GPNVS	2	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12		13

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	2
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Channel 1 Vrms	0.00 to 3.30 [V]
6.	Channel 2 Vrms	0.00 to 3.30 [V]
7.	Channel 3 Vrms	0.00 to 3.30 [V]
8.	Channel 4 Vrms	0.00 to 3.30 [V]
9.	Channel 5 Vrms	0.00 to 3.30 [V]
10.	Channel 6 Vrms	0.00 to 3.30 [V]
11.	Channel 7 Vrms	0.00 to 3.30 [V]
12.	Channel 8 Vrms	0.00 to 3.30 [V]
13.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,2,233518,092516,2.56,2.48,2.51,2.60,2.44,2.53, 2.51,2.60*6C

Note: For units with fewer than the number of channels listed, a null value will be present.

1.3 Status String ($GPNVS,3) Power Supply Values

$GPNVS	3	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n	nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13	14		15

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	3
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Power Supply 1	-30.0 to 30.0 [V]
6.	Power Supply 2	-30.0 to 30.0 [V]
7.	Power Supply 3	-30.0 to 30.0 [V]
8.	Power Supply 4	-30.0 to 30.0 [V]
9.	Power Supply 5	-30.0 to 30.0 [V]
10.	Power Supply 6	-30.0 to 30.0 [V]
11.	Power Supply 7	-30.0 to 30.0 [V]
12.	Power Supply 8	-30.0 to 30.0 [V]
13.	Built in Test (BIT)	0 = Ok, 1 = Fail
14.	Temperature (C)	-40 to 99
15.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,3,233518,092516,-7.84,7.93,-11.8,12.1,0.00,0.00,0.00,1.92,0,
26*62

Note: Depending on configuration, Power Supply values will be defined differently, and some Power Supply values may not be present.

1.4 Status String ($GPNVS,4) Channel Values 9-16

$GPNVS	4	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12		13

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	4
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Channel 9 Vrms	0.00 to 3.30 [V]
6.	Channel 10 Vrms	0.00 to 3.30 [V]
7.	Channel 11 Vrms	0.00 to 3.30 [V]
8.	Channel 12 Vrms	0.00 to 3.30 [V]
9.	Channel 13 Vrms	0.00 to 3.30 [V]
10.	Channel 14 Vrms	0.00 to 3.30 [V]
11.	Channel 15 Vrms	0.00 to 3.30 [V]
12.	Channel 16 Vrms	0.00 to 3.30 [V]
13.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,4,233518,092516,2.56,2.48,2.51,2.60,2.44,2.53,2.51,2.60*6A

Note: For units with fewer than the number of channels listed, a null value will be present.

1.5 Status String ($GPNVS,5) Sensors

$GPNVS	5	hhmmss	ddmmyy	nnn	nn	±nn	*	XX
1	2	3	4	5	6	7		8

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	5
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Potentiometer	Hex Value 000 to FFF
6.	Fan PWM %	0 to 90
7.	Temperature	-40 to 99 [C]
8.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,5,233518,092516,45,00,25*70

1.6 Status String ($GPNVS,6) Status Bytes; Standard

$GPNVS	6	0	A	0	0x0000	0x00	0x00	0x00	0	0x0000	0x0000	0x0000	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		14

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	6
3.	Active PCB Assembly	0 or 1
4.	GNSS Lock	A = Locked, V = Unlocked
5.	Input Error	0 = Ok, 1 = A Error, 2 = B error
6.	Channel Status Word	0x0000 to 0xFFFF
7.	Primary PS Status	0x00 to 0xFF
8.	Secondary PS Status	0x00 to 0xFF
9.	Active PCB Status	0x00 to 0xFF
10.	Checksum Status	00 to 999
11.	Channel Fault Bin	0x0000 to 0xFFFF
12.	Primary PCB Amp Status	0x0000 to 0xFFFF
13.	Backup PCB Amp Status	0x0000 to 0xFFFF
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,6,0,A,0,0x0000,0x40,0x40,0x00,00,0x0000,0x0000,0x0000*63

See Status Byte Table for details.

1.7 Status String ($GPNVS,7) Status Bytes

$GPNVS	7	nnnnnn	nnnnnn	A	nn	0x00	0	0	0	nnnnnn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		14

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	7
3.	Time	hhmmss
4.	Date	mmddyy
5.	GPS Lock	“A” = Valid, “V” = Not Valid
6.	# of Sats in View (1)	Greater of GPS or GNSS count, “N” = N/A
7.	Error Byte	0x00 to 0xFF
8.	Freq Diff	±999 (last count, clock cycles)
9.	PPS Diff	±999 (last count, clock cycles)
10.	Freq Correction Slice	±999 (DAC bits, per second)
11.	DAC Value	Integer Representation, n x 1/(2^20)
12.	Power Supply	Vdc
13.	Power Supply	Vdc
14.	NMEA Checksum	*XX (xor’d value of bytes between $ and *)

Example:
$GPNVS,7,161505,081617,A,12,0x00,-1,-2,0,505610,+5.05,-4.66*58

1.8 Event String ($GPNVS,8) Event Status

$GPNVS	8	0	0	0	0	0	0	0	nnnnnn	0	*	XX
1	2	3	4	5	6	7	8	9	10	11		12

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	8
3.	Discipline Counter	0 = Off, 1 = Disciplined to Synthetic PPS
4.	User Enabled	0 = Off, 1 = On
5.	Event Enabled (System)	0 = Events Disabled, 1 = Events Enabled
6.	GPS Lock Achieved	0 = No Lock, 2 = Locked or previously locked
7.	Event Index	0-512, Current count of events in RAM
8.	Event Errors (RAM)	0
9.	Event Index	0-512, Current count of events in Flash
10.	Event Errors (Flash)	0
11.	Event Time Alignmet	2 = LS applied, 1 = GPS, 0 = RTC
12.	Estimated Accuracy	0-999999 [ns]
13.	Edge Detect Direction	0 = Falling Edge, 1 = Rising Edge
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,8,1,1,1,2,0,0,2,000005,0*60

1.9 Status String ($GPNVS,9) Frequency Measurement (HS)

$GPNVS	9	nnnnnnn.nnn	n.nnnnn	nnnnnnnn.nn	0	±n.nn	±n.nn	±n.nn	±n.nn	*	XX
1	2	3	4	5	6	7	8	9	10		11

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	9
3.	Frequency (Loop Period)	10000000.000
4.	DAC Voltage (Double)	2.00000
5.	Frequency (per second)	10000000.0
6.	Loop Period	0-99
7.	Antenna Monitor	0.00 to 5.00V
8.	Sine Output RMS	0.00 to 3.30V
9.	Battery Voltage	0.00 to 24.0V (or NULL)
10.	Temperature	-40.0 to 99.9C
11.	Set temperature	0 to 99.9C
12.	Set temp reading	0 to 99.9C
13.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,9,+10000000.003,+1.97493,+10000000.0,15,+1.03,+1.30,,28.2,50.0,50.3,,,*4A

1.10 Status String ($GPNVS,10) PPS Status/Alignment

$GPNVS	10	0	0	0	±n	±n	n	n	n.n	n	n	n	0	±n	n.n	n	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17		18

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	10
3.	PPS Stability Enabled	0 = Off, 1 = On
4.	PPS Disciplining to GPS	0 = Off, 1 = Actively Synchronized
5.	PPS Output Type	0 = Synthetic PPS, 1 = GPS PPS
6.	PPS Difference	±250 [ns]
7.	PPS Avg Difference	±250 [ns]
8.	PPS Avg Count	1-20
9.	PPS Synch Threshold	1-250
10.	PPS pull Cal Factor	0.1 to 10.0
11.	PPS active Time Cal Factor	0 to 9
12.	Frequency Variance	0-9999 (clock cycles per Loop period)
13.	Frequency Var Threshold	0-100 (clock cycles per Loop period)
14.	PPS Stabile Mode Post-Warm up	0 = Off, 1 = On
15.	PPS Slope Indicator	±250 (clock cycles per second)
16.	PPS Slope Cal Factor	0.1 to 10.0
17.	PPS Slope Distance	14 to 60 (seconds)
18.	Phase pulse to wave	0-19
19.	Pulse Aligned	0 = False, 1 = True
20.	Target Pulse alignment	0-19
21.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,10,1,0,0,+0,+0,2,100,0.5,3,2,10,1,0,1.0,14,,,,*46

1.11 Status String ($GPNVS,11) Holdover

$GPNVS	11	00000	1	000000	1	1			±n.nn	n	*	XX
1	2	3	4	5	6	7	8	9	10	11		12

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	11
3.	Warmup Time Remaining	0-99999 [s]
4.	Warmup Period Complete	0=not complete, 1=complete
5.	Holdover Time Elapsed	0-999999 [s]
6.	Holdover Valid	0=not in spec, 1= in spec
7.	Frequency Valid	0=not valid, 1=valid
8.	PPS output control	0-2 (or NULL)
9.	PPS is enabled	0=PPS not enabled, 1=PPS not enabled (or NULL)
10.	Temperature	-40.0 to 99.9C
11.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,11,00000,1,000000,1,1,,,+28.1,*63

1.12 Status String ($GPNVS,12) Reserved

1.13 Status String ($GPNVS,13) External Discipline Selection

$GPNVS,	13,	n,	n,	n,	n,	n,	,	,	*	XX
1	2	3	4	5	6	7	8	9		10

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	13
3.	Priority Discipline Source	0 = GNSS, 1 = 10MHz input, 2 = Optical input
4.	Current Discipline Source	0 = GNSS, 1 = 10MHz, 2 = Optical, 3 = Holdover
5.	GNSS Lock	0 to 3, 0 = Unlocked, 2+ = Fully Locked
6.	RF Present	0 = No RF source, 1 = RF Source found
7.	Opto Present	0 = No Optical source, 1 = Optical Source Found
8.	Loop Lock	1 = Lock, 0 = Loop acquiring lock
9.	Reserved	
10.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,13,0,0,3,0,0,1,*5C

1.14 Status String ($GPNVS,14) Rubidium

$GPNVS	14	0	0	0x0010	0000	1	004	+0.00	0	*	XX
1	2	3	4	5	6	7	8	9	10		11

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	11
3.	Rb Status	8=Heat/Init, 5=Laser Lock, 0=Fully Locked
4.	Rb Alarm	0=Ok, <n>=Alarm Indicator
5.	Rb Mode	0x0000 to 0xffff
6.	Rb Steer	0000 to 9999
7.	Rb Disc Status	1=Disc Good, 2=Holdover, 0=Disciplining
8.	Rb last update	000 to 999[s]
9.	Rb Phase Offset	0.00000[ns]
10.	Rb Sourcing Holdover	0=GNSS, 1=Wait State Change, 2=Rb Holdover
11.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

1.15 Status String ($GPNVS,15) Rubidium 2

$GPNVS	15	1	6	4D00	2400	2400.00	00000000	0.00	0.00	0.00	0.00	+n	*	XX
1	2	3	4	5	6	7	8	9	10	11	12	13		

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	15
3.	Rb Lock	0= Init/No Lock, 1=Fully Locked
4.	Rb State	n Integer state of Rb Discipline
5.	Rb Status	0000 to FFFF
6.	Rb Fine Tune	0000 to 9999
7.	Rb Fine Tune Loop	0000.00 to 9999.99
8.	Rb Coarse Tune	00000000
9.	Rb TCXO Control	n.nn[V]
10.	Rb Laser Control	n.nn[V]
11.	Rb Laser	n.nn[V]
12.	Rb Cell Temp Control	n.nn[V]
13.	Rb Phase Offset	+/- n[cycles]
14.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

1.16 Status String ($GPNVS,16) Channel Values 17-24 (Bank B)

$GPNVS	16	hhmmss	ddmmyy	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	n.nn	*	XX
1	2	3	4	5	6	7	8	9	10	11	12		13

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	16
3.	Time (UTC)	hhmmss
4.	Date	mmddyy
5.	Channel 17 Vrms	0.00 to 3.30 [V]
6.	Channel 18 Vrms	0.00 to 3.30 [V]
7.	Channel 19 Vrms	0.00 to 3.30 [V]
8.	Channel 20 Vrms	0.00 to 3.30 [V]
9.	Channel 21 Vrms	0.00 to 3.30 [V]
10.	Channel 22 Vrms	0.00 to 3.30 [V]
11.	Channel 23 Vrms	0.00 to 3.30 [V]
12.	Channel 24 Vrms	0.00 to 3.30 [V]
13.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,16,233518,092516,2.56,2.48,2.51,2.60,2.44,2.53,
2.51,2.60*6C

Note: For units with fewer than the number of channels listed, a null value will be present.

1.17 Status String ($GPNVS,17) Reserved – Factory Use

1.18 Status Strings ($GPNVS,22 through $GPNVS,33) Reserved

1.19 Status String ($GPNVS,49)

$GPNVS	49	HHHHHHHH	HHHHHHHH		*	XX
1	2	3	4	5	6	

#	Description	Range
1.	Identifier	$GPNVS
2.	String ID	49
3.	Status Word (hex)	00000000 to FFFFFFFF
4.	Status Mask (hex)	00000000 to FFFFFFFF
5.	Factory Use	
6.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Bit	Description
0	Flash access failure
1	Failed attempt to save user data to flash
2	Loop DAC voltage out of range
3	N/A
4	GNSS setup not complete
5	Peripheral communication error
6	RAM memory monitor error
7	Frequency mesurement error
8	No valid lock source present for timing (PPS)
9	Loop is not in frequency specification or GNSS unlocked
10	Holdover period not within range
11	Channel output falls below minimum threshold
12	Power supply (+/-) is out of range
13	General Antenna Fault
14	Temperature out of range
15	Peripheral sensor failure in communication
16	Antenna current not within range (shorted or not connected)
17	Antenna voltage not within range (shorted)
18	External antenna connector DC not present (not connected)
19	GNSS position reported as not valid
20	GNSS time reported as not valid
21	GNSS is not reported as locked
22	Reserved
23	Reserved
24	Reserved
25	Reserved

1.R Response String ($GPNVS,R)

$GPNVS	R	n	<response>	*	XX
1	2	3	4		5

#	Description	Range
1.	Identifier	$GPNVS
2.	Response ID	R
3.	Command Success	1 = Success, 0 = Fail
4.	Response	<see example responses>
5.	NMEA Checksum	*XX (xor'd value of bytes between $ and *)

Example:
$GPNVS,R,SET01=1.00*6F

2.0 Status Byte Key

	Hex Value (OR'd)	Channel ID	Channel Status Word
Channel Status Byte	0x1<<0	Channel 1 Fault	General Channel Fault
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Channel ID	Channel Fault Bin
Channel Fault Bin	0x1<<0	Channel 1 Fault	External Fault: The ND0100 has completed an internal amplifier gain test and both primary and backup assemblies are functional. The fault is external to the ND0100 (cabling, short, etc) Amp Gain Test for Alert is enabled with $AMP=1 command via RS232
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Channel ID	Primary PCB Amp Status
Primary PCB Amp Status	0x1<<0	Channel 1 Fault	Internal Fault Primary Assembly: The channel has failed an internal gain test on the primary PCB assembly, and the channel is not functional on the primary board. Amp Gain Test for Alert is enabled with $AMP=1 command via RS232
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Channel ID	Backup PCB Amp Status
Backup PCB Amp Status	0x1<<0	Channel 1 Fault	Internal Fault Backup Assembly: The channel has failed an internal gain test on the backup PCB assembly, and the channel is not functional on the secondary board. Amp Gain Test for Alert is enabled with $AMP=1 command via RS232
	0x1<<1	Channel 2 Fault	
	0x1<<2	Channel 3 Fault	
	0x1<<3	Channel 4 Fault	
	0x1<<4	Channel 5 Fault	
	0x1<<5	Channel 6 Fault	
	0x1<<6	Channel 7 Fault	
	0x1<<7	Channel 8 Fault	
	0x1<<8	Channel 9 Fault	
	0x1<<9	Channel 10 Fault	
	0x1<<10	Channel 11 Fault	
	0x1<<11	Channel 12 Fault	
	0x1<<12	Channel 13 Fault	
	0x1<<13	Channel 14 Fault	
	0x1<<14	Channel 15 Fault	

	Hex Value (OR'd)	Status Message
Active Board Status	0x1<<0	Flash Read Boot Error (Deprecated)
	0x1<<1	Potentiometer Read/Set Fail
	0x1<<2	Reserved
	0x1<<3	Reserved
	0x1<<4	PCB Assembly Input A/B Select Fail
	0x1<<5	Reserved
	0x1<<6	Reserved
	0x1<<7	Reserved

	Hex Value (OR'd)	Status Message
Primary and Secondary Power Supply Status	0x1<<0	PS 1 Fault
	0x1<<1	PS 2 Fault
	0x1<<2	PS 3 Fault
	0x1<<3	PS 4 Fault
	0x1<<4	PS 5 Fault
	0x1<<5	PS 6 Fault
	0x1<<6	PS 7 Fault
	0x1<<7	PS 8 Fault

	Hex Value (OR'd)	Status Message
Error Status	0x1<<0	FLASH_NOT_FOUND
	0x1<<1	FLASH_NOT_SAVED
	0x1<<2	LOOP_VOLT_ERROR
	0x1<<3	ANTENNA_VOLT_ERROR
	0x1<<4	GPS_FAILURE
	0x1<<5	POTENTIOMETER_ERROR
	0x1<<6	RAM_MEMORY_ERROR
	0x1<<7	Reserved

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